PB-230 481

POLLUTION OF LAKE MICHIGAN AND ITS TRIBUTARY BASIN. PROCEEDINGS OF CONFERENCE HELD AT CHICAGO, ILLINOIS ON JANUARY 31, FEBRUARY 1-2, FEBRUARY 5-7, 1968. EXECUTIVE SESSION, MARCH 7, 8 AND 12, 1968. VOLUME V

Federal Water Pollution Control Administration
Washington, D.C.

March 1968

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U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 230 481

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Volume 5

ILLINOIS
INDIAN

Chicago, Illinois
Jan. 31, Feb. 1-2, Feb. 5-7, 196
Executive Session
March 7, 8 and 12, 1968

CONFERENCE

Pollution of Lake Michigan and its tributary basin

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U.S. Department of Commerce
Springfield VA 22151

U. S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

687

TUESDAY, FEBRUARY 6, 1968

MORNING SESSION

9:30 a.m.

MR. STEIN: Let's come to order.

We will now hear from Michigan. I would like to call on Mr. John Vogt.

MICHIGAN PRESENTATION

MR. VOGT: Mr. Chairman, for the record I will be Michigan's Conferee today and tomorrow as designated by Mr. George Liddle, the Chairman of the Michigan Water Resources Commission. I am the Chief of the Division of Engineering of the Michigan Department of Health and Vice Chairman of the Michigan Water Resources Commission.

Alternate Conferees will be Mr. Liddle, and also Mr. Ralph Purdy, Chief Engineer of the Michigan Water Resources Commission.

The Michigan Presentation today, Mr. Chairman, will involve a presentation of a joint report prepared by the Michigan Water Resources Commission and the Geological Survey Division of the Department of Conservation and the Michigan Department of Health.

We also have appearances by people who

have requested opportunity to make statements. Since we have previously informed those who have requested an opportunity to make appearances that they would be put on this morning, I plan on calling these people first, because some of them have other commitments and need to leave. So, therefore, we will hold our State Report until after the appearances have been made.

We also have some statements that have been presented to us which I will merely enter into the record, with your permission.

MR. STEIN: As I understand it, we have just two other commitments and that is Mr. Klassen has Mr. Egan, President of the Metropolitan Sanitary District of Greater Chicago. When he comes we will put him on. And when Governor Knowles comes, we expect him about 2 o'clock, we will make arrangements for the Governor to make his statement and try to fit in with the Governor's schedule. With the Governor, I imagine, we would have to find the closest breaking point and put him on as soon as we can to accommodate his schedule.

MR. VOGT: We will certainly do that.

Now, upon the announcement or the calling of the Conference by Secretary Udall, we sent out a letter to several hundred people in Michigan who we knew would be interested in this Conference, and I would like to introduce into the record a copy of this letter, a copy of the news release which the Michigan Water Resources Commission put out, and also a list of the people who received this letter.

MR. STEIN: Without objection, that will appear in the record as if read.

MR. VOGT: A copy of that is being distributed to the Conferees.

(Which said material is as follows:)

STATE OF MICHIGAN
GEORGE ROMNEY, GOVERNOR
DEPARTMENT OF CONSERVATION
RALPH A. MAC MULLAN, DIRECTOR

CONSERVATION COMMISSION	WATER RESOURCES COMMISSION
CARL T. JOHNSON Chairman	GEORGE F. LIDDLE Chairman
E. M. LAITALA	JOHN E. VOGT Vice Chairman
ROBERT C. McLAUGHLIN	R. DALE BALL
AUGUST SCHOLLE	GERALD E. EDDY
HARRY H. WHITELEY	JAMES W. MURRAY
	LYNN F. BALDWIN
	JIM GILMORE

300 MILL ST., LANSING 48926
Tel. 373-3560

December 29, 1967

Subject: Federal Conference on Pollution of Lake Michigan and its Tributary Basin

The Secretary of the Interior of the United States has called a conference on the pollution of Lake Michigan and its tributary basin (Wisconsin-Illinois-Indiana-Michigan) under the provisions of the Federal Water Pollution Control

Act (P.L. 84-660, as amended). The conference is called on the basis of a request from Governor Otto Kerner of Illinois, dated November 22, 1967, and on the basis of reports, surveys or studies available to the Secretary. Applicable portions of the Federal Act are quoted herewith:

Section 10

"(a) The pollution of interstate or navigable waters in or adjacent to any State or States (whether the matter causing or contributing to such pollution is discharged directly into such waters or reaches such waters after discharge into a tributary of such waters), which endangers the health or welfare of any persons, shall be subject to abatement as provided in this Act.

* * * * *

"(d) (1) Whenever requested by the governor of any State . . . , the Secretary shall, if such request refers to pollution of waters which is endangering the health or welfare of persons in a State other than that in which the

> discharge or discharges (causing or contributing to such pollution) originates, give formal notification thereof to the water pollution control agency . . . of the State or States where such discharge or discharges originate and shall call promptly a conference of . . . the State water pollution control agency . . . of the State or States, if any, which may be adversely affected by such pollution . . . The Secretary shall also call such a conference whenever, on the basis of reports, surveys or studies, he has reason to believe that any pollution referred to in subsection (a) and endangering the health or welfare of persons in a State other than that in which the discharge or discharges originate is occurring; . . ."

The conference will convene at 11:00 a.m., Wednesday, January 31, 1968, at the Sherman House, Chicago, Illinois.

Secretary Stewart L. Udall of the U. S. Department of the Interior will serve as Chairman of the conference. The Michigan Water Resources

Commission has designated its Executive Secretary, Loring F. Oeming, to participate in the conference as the State's conferee, with its Chief Engineer, Ralph W. Purdy, and its Chairman George F. Liddle or his representative as alternates.

Under the law, the purpose of the conference is to ascertain:

1. Whether pollution of Lake Michigan is occurring that is subject to abatement under the Federal Water Pollution Control Act.

2. The adequacy of measures taken toward abatement of the pollution.

3. The nature of delays, if any, being encountered in abating the pollution.

This announcement constitutes an invitation for you to attend or be represented at the Lake Michigan conference, and to inform you that the opportunity is available to you to make a statement. For accuracy of the record, any facts or views you wish to present should be submitted in writing. Your statement may be forwarded to this office before January 26 or may be filed with me at the time of the conference.

If you desire to present a statement for the record, please notify me not later than January 19, 1968.

Very truly yours,
WATER RESOURCES COMMISSION
(Signed) LORING F. OEMING
Loring F. Oeming
Executive Secretary

- - -

NEWS FROM MICHIGAN WATER RESOURCES COMMISSION

January 11, 1968

Michigan will be represented at the Federal conference on pollution of Lake Michigan and its tributary basin by Loring F. Oeming, executive secretary of the State Water Resources Commission. The conference will convene at 11 a.m., Wednesday, January 31, at the Sherman House, Chicago, Illinois. Called by Secretary of the Interior Udall who will serve as chairman, the conference also involves Wisconsin, Illinois and Indiana.

Under the law, the purpose of the

conference is three-fold. The conferees must determine (1) whether pollution of Lake Michigan is occurring that is subject to abatement under the Federal Water Pollution Control Act, (2) the adequacy of measures taken toward abatement of the pollution and (3) the nature of delays, if any, being encountered in abating the pollution.

The conference is open to the public and persons attending will be given an opportunity to make statements. For accuracy of the record, however, any facts or views to be presented should be submitted in writing. Statements may be mailed to the Water Resources Commission, 200 Mill Street, Lansing 48926, prior to January 26 or filed with the Commission's executive secretary at the time of the conference.

Over 450 notices of the Lake Michigan conference have been mailed by the Water Resources Commission to local units of government, industries, conservation groups and other organizations and interested citizens.

- - -

News Release re Federal conference on pollution of Lake Michigan and its tributary basin sent to: (listed by municipality)

Capitol Building Press Corps (20 copies)

MUCC Board of Directors (12 copies)

THE BENTON HARBOR NEWS PALLADIUM
Benton Harbor

CHARLEVOIX COURIER (weekly)
Charlevoix

ESCANABA DAILY PRESS
Escanaba

BENZIE COUNTY PATRIOT (weekly)
Frankfort

DELTA REPORTER (weekly)
Gladstone

GRAND HAVEN DAILY TRIBUNE
Grand Haven

THE WEEKLY WAVE (weekly)
Hessel

HILLSDALE DAILY NEWS
Hillsdale

HOLLAND EVENING SENTINEL
Holland

KALAMAZOO GAZETTE
Kalamazoo

THE STATE JOURNAL
Lansing

MICHIGAN-OUT-OF-DOORS (MUCC monthly)
Lansing

LEELANAU ENTERPRISE-TRIBUNE (weekly)
Leland

LUDINGTON DAILY NEWS
Ludington

MANISTEE NEWS ADVOCATE
Manistee

MANISTIQUE PIONEER TRIBUNE (weekly)
Manistique

THE HERALD-LEADER
Menominee

THE MUSKEGON CHRONICLE
Muskegon

NEW BUFFALO TIMES (weekly)
New Buffalo

NILES DAILY STAR
Niles

PETOSKEY NEWS-REVIEW
Petoskey

NORTH WOODS CALL (weekly)
Roscommon

THE ST. JOSEPH HERALD-PRESS
St. Joseph

ST. IGNACE REPUBLICAN NEWS AND
ST. IGNACE ENTERPRISE (weekly)
St. Ignace

SAUGATUCK COMMERCIAL-RECORD (weekly)
Saugatuck

SOUTH HAVEN DAILY TRIBUNE
South Haven

MENOMINEE COUNTY JOURNAL (weekly)
Menomine

THREE RIVERS COMMERCIAL
Three Rivers

THE RECORD EAGLE
Traverse City

WHITEHALL FORUM-WHITE LAKER (weekly)
Whitehall

WOOD NEWS (radio/TV)
Grand Rapids

TOTALS

Daily = 18
Weekly = 11
Monthly = 1
Radio/TV = 1
Others = 32
63

- - -

MAILING LIST

LAKE MICHIGAN CONFERENCE

International, National and Interstate Commissions

Leonard J. Goodsell, Executive Dir.
Great Lakes Commission
2200 N. Campus Boulevard
Ann Arbor, Michigan 48105

Hon. Matthew E. Welsh, Chairman
United States Section
International Joint Commission
1711 New York Avenue, N.W.
Washington, D.C. 20440

John P. Kavanaugh, Governors Alternate
Upper Great Lakes Regional Commission
Office of Economic Expansion
Department of Commerce
Lansing, Michigan (I.D.)

Norman S. Baldwin, Executive Secretary
Great Lakes Fishery Commission
1451 Green Road
P. O. Box 640
Ann Arbor, Michigan 48107

Raymond F. Clevenger, Chairman
Great Lakes Basin Commission
2200 North Campus Boulevard
Ann Arbor, Michigan 48105

Michigan State Agencies

R. G. Rice, M.D., Acting Director
Department of Public Health
3500 North Logan Street
Lansing, Michigan 48914 (I.D.)

George Romney, Governor
Office of the Governor
The State Capitol
Lansing, Michigan (I.D.)

Michigan Natural Resources Council
Department of Conservation
Lansing, Michigan 48926 (I.D.)

Herbert DeJonge, Director
Department of Commerce
Lansing, Michigan (I.D.)

B. Dale Ball, Director
Department of Agriculture
Lewis Cass Office Building
Lansing, Michigan 48913 (I.D.)

Keith Wilson, Director
Waterways Division
Michigan Department of Conservation
1004 Cadillac Square Building
Detroit, Michigan 48226

William T. McGraw, Director
Tourism Division
Michigan Department of Conservation
Lansing, Michigan (I.D.)

Kenneth Dorman, Sec.-Mgr.
Upper Michigan Tourist Council
Box 1188
Iron Mountain, Michigan 49806

Henrik Stafseth, Director
Department of State Highways
Lansing, Michigan (I.D.)

Cletus Courchaine, Eng. in Charge
Northern Peninsula Office
Department of Public Health
305 Ludington Street
Escanaba, Michigan 49829

Aurey Strohpaul, Sec.-Mgr.
West Michigan Tourist Association
107 Pearl Street, N.E.
Grand Rapids, Michigan 49502

R. G. Hill, Executive Sec.
State Soil Conservation Committee
Room 324 Natural Resources Building
East Lansing, Michigan 48823

Ralph A. Mac Mullan, Director
Department of Conservation
Lansing, Michigan (I.D.)

Members of Water Resources Commission

George F. Liddle (Chairman, representing
Municipal Groups
John Vogt, for Director of Public Health
Gerald E. Eddy, for Director of Conservation
Stanley Quackenbush, for Director of Agriculture
James V. Murray, for State Highway Commission
Lynn F. Baldwin, for Conservation Groups
James Gilmore, Jr., for Industrial Groups

Michigan Legislators

Secretary of Senate

Senators

Harold W. Hungerford
Gordon Rockwell
Emil Lockwood
Robert Vanderlaan
Milton Zaagman
Oscar E. Bouwsma
John F. Toepp
Thomas F. Schweigert
Joseph S. Mack
Gilbert E. Bursley
James G. Fleming
Harry A. DeMaso
Anthony Stamm
Charles O. Zollar

House of Representatives - Clerk of the House

Frederic J. Marshall
DeForrest Strang
Don R. Pears
Lionel J. Stacey
James H. Heinze
William V. Weber
Cyril H. Root

J. E. VOGT

House of Representatives - Clerk of the House Continued

Edson V. Root, Jr.
James S. Farnsworth
Dale Warner
Thomas L. Brown
Phillip O. Pittinger
Thomas G. Ford, Sr.
Stanley J. Davis
Peter Kok
Johannes C. Kolderman, Jr.
Melvin DeStiger
Francis W. Beedon
Edgar A. Geerlings
Nelson G. Tisdale
Robert W. Davis
Dominic J. Jacobetti
Blair C. Woodman
Lester J. Allen
Stanley M. Powell
Martin D. Buth
Dennis O. Cawthorne
Donald E. Holbrook, Jr.

Russell H. Strange
Arnell Engstrom
Charles H. Varnum
Jack L. Gingrass

James N. Folks
Hal W. Ziegler
Thomas G. Sharpe
Charles J. Davis

5. **Legislative Committees**

Senate Special Committee to Study Problems Concerning the Great Lakes and Their Tributaries. Chairman - Sen. Charles O. Zollar.

Senate Special Committee on Fishing in the Great Lakes. Chairman - Sen. John F. Toepp

Legislative Committees (Continued)

Joint Legislative Committee on Water Resources Planning
Co-Chairman - Representative Raymond J. Baker
Co-Chairman - Senator Gordon Rockwell

Senate Committee on Conservation and Tourist Industry.
Chairman - Senator Gordon Rockwell

House Committee on Conservation and Recreaton.
Chairman - Representative Raymond J. Baker

6. Congressmen

United States Senators

Senator Phillip A. Hart
Senate Office Building
Washington, D.C.

Senator Robert P. Griffin
Senate Office Building
Washington, D.C.

United States Representatives

Representative Marvin L. Esch
House Office Building
Washington, D.C.

Representative Garry Brown
House Office Building
Washington, D.C.

United States Representatives (Continued)

Representative Edward Hutchinson
House Office Building
Washington, D.C.

Representative Gerald L. Ford
House Office Building
Washington, D.C.

Representative Charles E. Chamberlain
House Office Building
Washington, D.C.

Representative Guy Vander Jagt
House Office Building
Washington, D.C.

Representative Elford A. Cederberg
House Office Building
Washington, D.C.

Representative Philip E. Roppe
House Office Building
Washington, D.C.

7. Townships

Joseph A. Parisi, Jr., Exec. Dir.
Michigan Townships Association
712 South Holmes
Lansing, Michigan 48912

8. Municipalities

Robert E. Fryer, Director
Michigan Municipal League
205 South State Street
Ann Arbor, Michigan 48104

9. Planning Commissions

Bruce Brown, Exec. Sec.
Michigan Society of Planning Officials
1937 Cromwell Drive
Holt, Michigan 48842

10. Watersheds

John H. Kennaugh, Exec. Sec.
Grand River Watershed Council
609 Prudden Building
Lansing, Michigan 48933

11. Conservation - Recreation

Merrill Petoskey, Secretary
Michigan Association of Cons. Ecologists
408 Kalamazoo Plaza
Lansing, Michigan 48914

James L. Rouman, Exec. Dir.
Michigan United Conservation Clubs
P. O. Box 2235
Lansing, Michigan, 48911

Conservation - Recreation (Continued)

Charles Welch, Secretary
Michigan Outdoor Writers Assoc.
P. O. Box 128
500 Lake Avenue
Roscommon, Michigan 48653

Norm Spring, President
Michigan Steelheaders Assoc.
1416 Lake Street
Grand Haven, Michigan 49417

Howard Brown, President
Upper Peninsula Sportsmens Assoc.
Newberry, Michigan 49868

American Power Boat Association.
Whittier Hotel
415 Burns Drive
Detroit, Michigan 48214

Tudar ApMadoc, Chairman
Michigan Council - Trout Unlimited
2526 State Street
Saginaw, Michigan 48602

Miss Olga Madar, Director
U.A.W. Recreation Department
8000 East Jefferson Avenue
Detroit, Michigan 48214

David H. Rathbun, Outstate Chairman
Ducks Unlimited
1109 Security Bank Building
Battle Creek, Michigan 49014

Conservation - Recreation (Continued)

Mrs. Harry H. Geitgey
D.A.R. Conservation Chairman
3995 Berry Road
Plymouth, Michigan 48170

John R. Spyker
Michigan Salmon Anglers
Box 192
Grandville, Michigan 49148

Mr. Fred Lefton, Executive Director
Outboard Boating Club of America
333 North Michigan Avenue
Chicago, Illinois 60601

12. AGRICULTURE

Daniel E. Reed, President
Michigan Farm Bureau
P.O. Box 96
Lansing, Michigan 48925

Grover Grigsby, Master
Michigan State Grange
314 North Walnut
Lansing, Michigan 48933

13. Industrial and Commercial

John C. McCurry, General Manager
Michigan Manufacturers Association
1590 First National Building
Detroit, Michigan 48226

14. Organizations

Harry Hall, Exec. Vice President
Michigan State Chamber of Commerce
215 South Washington Avenue
Lansing, Michigan 48925

John J. Carey, President
Michigan Society of Professional Eng.
Electrical Engineering Department
University of Michigan
Ann Arbor, Michigan

Miss Sadle Jones
Michigan Federation of Womens Club
416 North Clinton, Box 30
Grand Ledge, Michigan 48837

League of Women Voters of Michigan
4612 Woodward
Detroit, Michigan 48201

Donald M. Pierce, Secretary
Michigan Water Pollution Control Assoc.
Michigan Department of Public Health
3500 North Logan Street
Lansing, Michigan (I.D.)

Roy Jensen, Executive Secretary
Michigan Fish Producers Association
Route 62
Escanaba, Michigan

- - -

LAKE MICHIGAN ENFORCEMENT CONFERENCE

Municipalities

1. Mayor and Council
City of Albion
112 West Cass Street
Albion, Michigan 49224

2. Mayor and Council
City of Allegan
112 Locust Street
Allegan, Michigan 49010

3. President and Council
Village of Alpha
Alpha, Michigan 49902

4. President and Council
Village of Bangor
Pine Street
Bangor, Michigan 49013

5. Mayor and Commission
City of Battle Creek
E. Michigan Avenue at
E. Division Street
Battle Creek, Michigan 49014

6. Mayor and Council
City of Belding
Belding, Michigan 48809

7. Mayor and Commission
City of Benton Harbor
200 Wall Street
Benton Harbor, Michigan 49022

8. President and Council
Village of Berrien Springs
123 West Ferry Street
P.O. Box 182
Berrien Springs, Michigan 49103

9. President and Council
Village of Beulah
7228 Commercial Avenue
Beulah, Michigan 49617

10. Mayor and Commission
City of Big Rapids
226 North Michigan Avenue
Big Rapids, Michigan 49307

11. Mayor and Commission
City of Boyne City
100 State Street
Boyne City, Michigan 49712

12. Mayor and Commission
City of Bridgman
582 Lake Street
Bridgman, Michigan 49106

13. Mayor and Council
City of Bronson
114 East Chicago Street
Bronson, Michigan 49028

14. Mayor and Commission
City of Buchanan
107 West Front Street
Buchanan, Michigan 49107

15. Mayor and Commission
City of Cadillac
201 North Mitchell Street
Cadillac, Michigan 49601

16. President and Council
Village of Caledonia
Caledonia, Michigan 49316

17. Mayor and Commission
City of Caspian
340 Caspian Avenue
Caspian, Michigan 49915

18. President and Council
Village of Cassopolis
120 North Disbrow Street
Cassopolis, Michigan 49031

19. Mayor and Council
City of Cedar Springs
66 South Main Street
Cedar Springs, Michigan 49319

20. Mayor and Council
City of Charlevoix
210 State Street
Charlevoix, Michigan 49720

21. Mayor and Council
City of Charlotte
146 South Bostwick Avenue
Charlotte, Michigan 48813

22. Mayor and Council
City of Coldwater
5 South Monroe Street
Coldwater, Michigan 49036

23. Mayor and Commission
City of Coloma
144 North Church Street
Coloma, Michigan 49038

24. Mayor and Council
City of Coopersville
289 Dandorth
Coopersville, Michigan 49404

25. Delhi Township, Ingham County
Township Hall
Holt, Michigan
Attention: Mrs. Enid M. Lewis, Clerk

26. Delta Township, Eaton County
Route 2
Lansing, Michigan
Attention: Mrs. Dorothy I. Staley, Clerk

27. Mayor and Council
City of DeWitt
DeWitt, Michigan 48820

28. Mayor and Council
City of Dowagiac
241 South Front
Dowagiac, Michigan 49047

29. Mayor and Commission
City of East Jordan
201 Main Street
East Jordan, Michigan 49727

30. Mayor and Council
City of East Lansing
410 Abbott Road
East Lansing, Michigan 48823

31. Mayor and Commission
City of Eaton Rapids
Corner Main and Hamlin Streets
Eaton Rapids, Michigan 48827

32. President and Council
Village of Edmore
Edmore, Michigan 48829

33. President and Council
Village of Elberta
Elberta, Michigan 49628

34. President and Council
Village of Elk Rapids
131 River Street
Elk Rapids, Michigan 49629

35. Mayor and Council
City of Escanaba
121 South 11th Street
Escanaba, Michigan 49829

36. Mayor and Council
City of Evart
101 North Pine Street
Evart, Michigan 49631

37. Mayor and Council
City of Fennville
117 North Maple Street
Fennville, Michigan 49408

38. President and Council
Village of Fowler
South Main Street
Fowler, Michigan 48835

39. President and Council
Village of Fowlerville
105 Power Street
Fowlerville, Michigan 48836

40. Mayor and Council
City of Frankfort
412 Main Street
Frankfort, Michigan 49635

41. Mayor and Commission
City of Fremont
101 East Main Street
Fremont, Michigan 49412

42. Mayor and Commission
City of Gaastra
Main Avenue
Gaastra, Michigan 49927

43. Mayor and Commission
City of Gladstone
1100 Delta Avenue
Gladstone, Michigan 49837

44. Mayor and Council
City of Grand Haven
519 Washington Street
Grand Haven, Michigan 49417

45. Mayor and Commission
City of Grand Ledge
120 South Bridge Street
Grand Ledge, Michigan 48837

46. Mayor and Commission
City of Grand Rapids
35 Lyon Street, N.W.
Grand Rapids, Michigan 49502

47. Mayor and Commission
City of Grandville
3063 Wilson Avenue, S.W.
Grandville, Michigan 48418

48. President and Council
Village of Grant
Grant Michigan 49327

49. Mayor and Council
City of Greenville
401 South Lafayette Street
Greenville, Michigan 48838

50. Harbor Point Association
Harbor Point, Michigan 49740

51. Mayor and Council
City of Harbor Springs
349 East Main Street
Harbor Springs, Michigan 49740

52. Mayor and Council
City of Hart
218 Washington Street
Hart, Michigan 49420

53. Mayor and Council
City of Hartford
7 East Main Street
Hartford, Michigan 49057

54. Mayor and Council
City of Hastings
102 South Broadway
Hastings, Michigan 49058

55. Mayor and Council
City of Hillsdale
Corner Broad and Hillsdale Streets
Hillsdale, Michigan 49242

J. E. VOGT

56. Mayor and Council
City of Holland
270 River Avenue
Holland, Michigan 49423

57. President and Council
Village of Homer
112 West Adams Street
Homer, Michigan 49245

58. Mayor and Council
City of Ionia
114 North Kidd Street
Ionia, Michigan 48846

59. Mayor and Commission
City of Iron River
106 West Genessee Street
Iron River, Michigan 49935

60. Mayor and Council
City of Iron Mountain
206-208 East Ludington Street
Iron Mountain, Michigan 49801

61. Mayor and Commission
City of Jackson
132 West Washington Street
Jackson, Michigan 49201

62. Mayor and Commission
City of Kalamazoo
241 West South Street
Kalamazoo, Michigan 49006

63. Mr. John F. Meacham, Director
Kent County Board of Aeronautics
3206 Madison Avenue, S.E.,
Grand Rapids, Michigan

64. President and Council
Village of Kent City
Kent City, Michigan 49330

65. Mayor and Council
City of Kingsford
305 South Carpenter Avenue
Kingsford, Michigan 49802

66. President and Counsil
Village of Lake Odessa
Page Memorial Building
Lake Odessa, Michigan 48849

67. President and Council
Village of Lakeview
Lincoln Avenue
Lakeview, Michigan 48850

68. Mayor and Council
City of Lansing
111 West Michigan Avenue
Lansing, Michigan 48933

69. President and Council
City of Lawrence
Lawrence, Michigan 49064

70. President and Council
City of Lawton
South Main Street, Box 399
Lawton, Michigan 49065

71. President and Council
Village of Leslie
107 East Bellevue Street
Leslie, Michigan 49251

72. Mayor and Council
City of Lowell
301 East Main Street
Lowell, Michigan 49331

73. Mayor and Commission
City of Ludington
205 South William Street
Ludington, Michigan 49431

74. Mayor and Commission
City of Manistee
78 Maple Street
Manistee, Michigan 49660

75. Mayor and Council
City of Manistique
East Lake Shore Drive
Manistique, Michigan 49854

76. Mayor and Commission
City of Marshall
323 West Michigan Avenue
Marshall, Michigan 49068

77. Mayor and Council
City of Mason
137 West Maple Street
Mason, Michigan 48854

78. Mayor and Council
City of Menominee
711 First Street
Menominee, Michigan 49858

79. President and Council
Village of Middleville
High Street
Middleville, Michigan 49333

J. E. VOGT

80. Mayor and Commission
City of Muskegon
208 West Clay Avenue
Muskegon, Michigan 49443

81. Mayor and Council
City of Muskegon Heights
2724 Peck Street
Muskegon Heights, Michigan 49444

82. President and Council
Village of Nashville
Nashville, Michigan 49073

83. Mayor and Council
City of New Buffalo
224 West Buffalo Street
New Buffalo, Michigan 49117

84. President and Council
Village of Newaygo
Community Building
Newaygo, Michigan 49337

85. Mayor and Council
City of Niles
506 East Main Street
Niles, Michigan 49120

86. Mayor and Council
City of North Muskegon
1502 Ruddiman Avenue
North Muskegon, Michigan 49445

87. Mr. Ronald W. Ruscett
Director of Water Utilities
Ottowa County Road Commission
616 North 6th Street
Grand Haven, Michigan

88. Mayor and Commission
City of Otsego
117 East Orleans
Otsego, Michigan 49078

89. Mayor and Commission
City of Parchment
650 South Riverview Avenue
Parchment, Michigan 49004

90. President and Council
Village of Paw Paw
111 East Michigan Avenue
Paw Paw, Michigan 49079

91. President and Council
Village of Pentwater
Pentwater, Michigan 49449

92. Mayor and Council
City of Petoskey
200 Division Street
Petoskey, Michigan 49770

93. Mayor and Council
City of Plainwell
323 East Bridge Street
Plainwell, Michigan 49080

94. Mayor and Council
City of Portage
7800 Shaver Road
Portage, Michigan 49081

95. President and Council
Village of Portland
259 Kent Street
Portland, Michigan 48875

96. President and Council
Village of Quincy
17-19 West Chicago Street
Quincy, Michigan 49082

97. Mayor and Council
City of Reed City
201 West Upton Street
Reed City, Michigan 49677

98. Mayor and Council
City of Rockford
8 East Bridge Street
Rockford, Michigan 49341

99. Mayor and Commission
City of St. Johns
121 East Walker Street
St. Johns, Michigan 48879

100. Mayor and Commission
City of St. Joseph
616-620 Broad Street
St. Joseph, Michigan 49085

101. President and Council
Village of Saugatuck
201 Butler Street
Saugatuck, Michigan 49453

102. Mayor and Commission
City of Scottville
105 North Main Street
Scottville, Michigan 49454

103. Mayor and Council
City of South Haven
529½ Phoenix Street
South Haven, Michigan 49090

104. President and Council
Village of Sparta
156 East Division Street
Sparta, Michigan 49345

105. President and Council
Village of Spring Lake
102 West Savidge Street
Spring Lake, Michigan 49456

106. Mayor and Commission
City of Stambaugh
208 Third Street
Stambaugh, Michigan 49964

107. President and Council
Village of Stephenson
Stephenson, Michigan 49887

108. Mayor and Commission
City of Sturgis
124 N. Nottawa Street, P.O. Box 280
Sturgis, Michigan 49091

109. President and Council
Village of Suttons Bay
Suttons Bay, Michigan 49682

110. Mayor and Commission
City of Three Rivers
29 North Main Street
Three Rivers, Michigan 49093

111. Mayor and Commission
City of Traverse City
160 East State Street
Traverse City, Michigan 49684

112. President and Council
Village of Union City
Union City, Michigan 49094

113. President and Council
Village of Vicksburg
202 South Main Street
Vicksburg, Michigan 49097

114. Mayor and Commission
City of Watervliet
Corner Pleasant & First Streets
Watervliet, Michigan 49098

115. Wequestonsing Association
Ind. Br. Harbor Springs
Harbor Springs, Michigan 49740

116. Mayor and Council
City of Whitehall
405 East Colby Street
Whitehall, Michigan 49461

117. Mayor and Council
City of White Cloud
1020 Wilcox Avenue
White Cloud, Michigan 49349

118. Mayor and Council
City of Williamston
161 East Grand River Avenue
Williamston, Michigan 48895

119. Mayor and Commission
City of Wyoming
1155 28th Street, West
Wyoming, Michigan 49509

120. Mayor and Council
City of Zeeland
21 South Elm Street
Zeeland, Michigan 49464

121. Kent County Department of Public Works
1500 Scribner Avenue, N.W.
Grand Rapids, Michigan 49504

122. Mr. Frank W. Bouma
Kent County Drain Commissioner
1500 Scribner Avenue, N.W.
Grand Rapids, Michigan

- - -

MAILING LIST

LAKE MICHIGAN CONFERENCE

Industries

Albion Malleable Iron Company
601 North Albion Street
Albion, Michigan 49224

Allegan Metal Finishing Company
Allegan, Michigan 49010

Allied Paper Corporation
Monarch Division
1608 Lake Street
Kalamazoo, Michigan 49001

Lakeshore Division
Bendix Corporation
U. S. 12
St. Joseph, Michigan 49085

Bill-Mar Poultry
Borculo, Michigan 49464

Bissell, Incorporated
Box 1888, 2345 Walker, N.W.
Grand Rapids, Michigan 49501

Bohn Aluminum and Brass Company
365 West 24th Street
Holland, Michigan 49423

Brooks and Perkins, Inc.
Cadillac Manufacturing Division
101 Haynes Street
Cadillac, Michigan 49601

Brunswick Corporation
2605 Kilgore, Box 2111
Kalamazoo, Michigan 49003

Burnette Farms Packing Company
Lawrence, Michigan 49064

Burnette Farms Packing Company
805 Griswold Street
Hart, Michigan 49420

Campbell, Wyant and Cannon Foundry Company
Roosevelt Park
Henry Street
Muskegon, Michigan 49444

Campbell, Wyant and Cannon Foundry Company
Muskegon Heights, Michigan 49444

Carnation Milk Company
Sheridan, Michigan 48884

Central Concrete Products Company
15151 Mill Pond Road
Big Rapids, Michigan 49307

Chase Manufacturing
Division of Gulf and Western
(Scott's Incorporated)
281 Chase Road
Douglas, Michigan 49406

Chef Pierre, Inc.
Box 544, Cass Road
Traverse City, Michigan 49684

Allied Paper Corporation
King Division
1608 Lake Street
Kalamazoo, Michigan 49001

Alpha, Incorporated
Eau Claire, Michigan 49111

Aluminum Extrusions, Inc.
Charlotte, Michigan 48813

American Aggregates Corporation
Box 728, 8600 North Westnedge
Kalamazoo, Michigan 49001

American Motors Corporation
Kelvinator Division
1545 Clyde Park, S.W.
Grand Rapids, Michigan 49509

Amway Corporation
7575 East Fulton
Ada, Michigan 49301

Ashley Corporation
P.O. Box 245
Ashley, Michigan 48806

ASP & Manufacturing Company
702 North 6th Street
Grand Haven, Michigan 49417

Attwood Corporation
1016 North Monroe
Lowell, Michigan 49331

Aunt Janes' Foods
Division of Borden Company
Edmore, Michigan 48829

Chemical Processes of Ohio
Northport, Michigan 49670

Cherry Growers, Inc.
709-715 East Front Street
Traverse City, Michigan 49684

Clark Equipment Company
324 East Dewey
Buchanan, Michigan 49107

Clark Equipment Company
1300 Falahee Road
Jackson, Michigan 49204

Clark Equipment Company
Pipestone Road
Benton Harbor, Michigan 49022

Coloma Cooperative Canning Company
West Street
Coloma, Michigan 49038

Columbia Foods Division
Michigan Fruit Canners, Inc.
Main and Ash Streets
Ellsworth, Michigan 49729

Constantine Paperboard Division
The Davey Company
Centerville Road
Constantine, Michigan 49042

Consumers Power Company
Big Rock Point
Box 338
Charlevoix, Michigan 49720

Consumers Power Company
P.O. Box 6
Comstock, Michigan 49041

William Reid
Consumers Power Company
Jackson, Michigan 49203

Consumers Power Company
Port Sheldon, Michigan

Continental Motors Corporation
205 Market Street
Muskegon, Michigan 49443

Continental Motors Corporation
76 North Getty Street
Military Division
Muskegon, Michigan 49443

J. E. VOGT

Clark Equipment
24th Street
Battle Creek, Michigan 49015

Corning Glass Works
North and Clark Streets
Albion, Michigan 49224

Crystal Refining Company
901 North Williams
Carson City, Michigan 48811

Crystal Pure Vinegar
Belding, Michigan 48809

Daggett Cheese Factory
Daggett, Michigan 49821

Detroit Gasket and Manufacturing Company
Extruded Metal Division
Belding, Michigan 48809

The Dow Chemical Company
Madison and 7th Streets
Ludington, Michigan 49431

E. I. Dupont de Nemours and Co., Inc.
P. O. Box A
Montague, Michigan 49437

Donnelly Mirrors
49 West Third Street
Holland, Michigan 49423

Du-Wel Decorative Company
P.O. Box 307
Bangor, Michigan 49013

Eagle-Ottawa Leather Company
200 North Beechtree Street, Box 308
Grand Haven, Michigan 49417

East Jordan Canning Company
East Jordan, Michigan 49727

Eaton, Yale and Towne, Inc.
Fuller Transmission Division
222 East Mosel Avenue
Kalamazoo, Michigan 49001

Eaton, Yale and Towne, Inc.
Valve Division
462 North 20th Street
Battle Creek, Michigan 49016

Eaton, Yale and Towne, Inc.
West Hanover Street
Marshall, Michigan 49068

Eau Claire Packing Company
Box 152
Eau Claire, Michigan 49111

Elberta Packing Company
100 Frankfort Street
Elberta, Michigan 49628

Electro Chemical Finishing Company
Middleville, Michigan 49333

Elk Rapids Packing Company
Box 128, 701 U.S. 31
Elk Rapids, Michigan 49629

Elk Rapids Packing Company
Lake Leelanau, Michigan 49653

Evart Products Company
601 West 7th Street, Box F
Evart, Michigan 49631

Faas Foods, Inc.
Central Lake, Michigan 49622

Federal Mogul Corporation
510 East Grove
Greenville, Michigan 48838

French Paper Company
100 French Street, Box 214
Niles, Michigan 49120

Fresh-Pak Corporation
1790 Second Street
Martin, Michigan 49070

Frigid Foods, Inc.
Suttons Bay, Michigan 49682

Frigo Brothers
Carney, Michigan 49812

General Foods Corporation
275 Cliff Street
Battle Creek, Michigan 49017

General Foods Corporation
Liberty Dairy
North River Street
Evart, Michigan 49631

General Motors Corporation
Fisher Body Plant No. 2
2060 Voorhies, N.W.
Grand Rapids, Michigan 49504

Gerber Products Company
445 State Street
Fremont, Michigan 49412

Gibson Refrigerator Company
515 West Gibbon Drive
Greenville, Michigan 48838

Gibson Refrigerator Company
122 North Ashfield
Belding, Michigan 48809

Grand Haven Brass Foundry
230 North Hopkins Street
Grand Haven, Michigan 49417

Grand Trunk Railroad Company
Car Shops
Battle Creek, Michigan 49014

Hanna, M. A. Ore Company
Iron River, Michigan 49935

Harbison-Walker Refractories Company
U.S. 31, Box 189
Ludington, Michigan 49431

Hart Cherry Packers, Inc.
100 Union Street
Hart, Michigan 49420

J. E. VOGT

Hart and Cooley Manufacturing Company
500 East 8th Street
Holland, Michigan 49423

Hartford Metal Protection Company
520 Heywood Street
Hartford, Michigan 49057

Hastings Aluminum Products, Inc.
Box 230, 429 South Michigan
Hastings, Michigan 49058

Hastings Manufacturing Company
325 Hanover
Hastings, Michigan 49058

Hawthorne Paper Company
Box 2858 Kings Highway
Kalamazoo, Michigan 49003

Heinz, H. J. Company
431 West 16th Street
Holland, Michigan 49423

Hilfinger-Jackson Corporation
654 Hupp Avenue
Jackson, Michigan 49203

Holland Suco Color Company
471 Howard
Holland, Michigan 49423

Holland Die Casting and Plating Co., Inc.
582 East Lakewood
Holland, Michigan 49423

Honee Bear Syrup Canning Company, Inc.
RFD #2
Lawton, Michigan 49065

Hooker Chemical Company
Whitebeck Road
Montague, Michigan 49437

Howes Leather Company, Inc.
W. Front, P.O. Box 97
Boyne City, Michigan 49712

Hudsonville Creamery and Ice Cream Company
Burnips, Michigan 49314

Hudsonville Dairy
3300 Van Buren
Hudsonville, Michigan 49424

Humboldt Mining Company
504 Spruce Street
Ishpeming, Michigan 49849

General Motors Corporation
Oldsmobile Division
1014 Townsend Street
Lansing, Michigan 48921

Grand Rapids Brass Company
Division Crampton Mfg. Co.
420-50th Street, S.W.
Box 1687
Grand Rapids, Michigan 49501

Industrial Rubber Goods Division
St. Joseph, Michigan 49085

Inland Lime and Stone Company
Gulliver, Michigan 49840

Inland Steel Company
Sherwood Mine
Iron River, Michigan 49935

Jervis Corp.
2900 Wilson, S.W.
Grandville, Michigan 49418

Kalamazoo Paper Company
Mills 1-2-3
Box 2738
Kalamazoo, Michigan 49003

Kalamazoo Rendering Company
6300 East Main
P.O. Box 868
Kalamazoo, Michigan 49004

Kawneer Company
1105 North Front Street
Plant #1
Niles, Michigan 49120

Kaydon Engineering Corp.
2860 McCracken Street
Muskegon, Michigan 49443

Keeler Brass Company
State Street
Middleville, Michigan 49333

Kellogg Company
235 Porter Street
Battle Creek, Michigan 49016

Kingston Products Corp.
Douglas Manufacturing
141 Railroad
Bronson, Michigan 49028

Kirsch Manufacturing Company
309 North Prospect Street
P.O. Box 391
Sturgis, Michigan 49091

Brown Company
KVP Sutherland
Kalamazoo, Michigan 49007

Lakeside Refining Company
2705 East Cork
Kalamazoo, Michigan 49001

Lamb-Knit Goods
Elm Street
Colon, Michigan 49040

Lamina Tool and Die Corp.
Lamina Bronze Products
Division of Lamina, Inc.
Bellaire, Michigan 49615

Leelanau Fruit Company
Suttons Bay, Michigan 49682

Lefere Forge and Machine Company
665 Hupp Avenue
Jackson, Michigan 49203

Light Metals Corporation
Prairie Avenue, 2740 Prairie S.W.
Grand Rapids, Michigan 49509

Lortin Products Company
East Saugatuck, Michigan 49407

Manistee Salt Works
1501 Main Street
Manistee, Michigan 49660

Manistique Pulp and Paper Company
P.O. Box 111
S. Mackinac Avenue
Manistique, Michigan 49854

Marathon Division
American Can Company
144 First Street
Menominee, Michigan 49858

Marquette Iron Mining Company
Republic Mine
Republic, Michigan 49879

Mason County Cherry Packers
Ludington, Michigan 49431

Mead Corporation
Escanaba Division
Escanaba, Michigan 49829

Mead, Johnson and Company
725 East Main Street
Zeeland, Michigan 49464

Menasha Corporation
Paperboard Division
Box 155, N. Farmer Street
Otsego, Michigan 49078

Meyer Provision Company
Iron River, Michigan 49935

Michigan Consolidated Gas Company
Six Lakes, Michigan 48886

Michigan Fruit Canners, Inc.
Fennville, Michigan 49408

Michigan Milk Producers Assoc.
Ovid, Michigan 48866

Michigan Mushroom Company
Niles, Michigan 49120

Midland Wire Corporation
616 Fourth
Three Rivers, Michigan 49093

Midway Packing Company
926 South Main
Wayland, Michigan 49348

Midwest Timer Service, Inc.
Box 146
Benton Harbor, Michigan 49022

Miles Laboratories, Inc.
Zeeland Plant
209 North Centennial
Zeeland, Michigan 49464

Millburg Fruit Exchange
Millburg, Michigan 49022

Miller Industries, Inc.
Plant No. 1
Reed City, Michigan 49677

Germay Division
Miller Industries, Inc.
P.O. Box 157
Reed City, Michigan 49677

Misco Precision Casting Company
116 West Gibbs
Whitehall, Michigan 49461

Morgan-McCool, Inc.
102 Grandview Parkway
Traverse City, Michigan 49684

Morton Chemical Company
Foot of 6th
Manistee, Michigan 49660

Murch, A. F. & Co.
R.F.D. No. 1
Paw Paw, Michigan 49079

Murray Packing Company, Inc.
11-11th Street, Box 175
Plainwell, Michigan 49080

Naph-Sol Refining Company
North Muskegon, Michigan 49445

National Fruit Product Company, Inc.
Kent City, Michigan 49330

National Gypsum Company
Kings Highway, Box 2152
Kalamazoo, Michigan 49001

Nelson Metal Products Division
Midland Ross Corporation
2980 Prairie Street
Grandville, Michigan 49418

New Era Canning Company
New Era, Michigan 49446

New York Airbrake Company
Galesburg, Michigan 49053

New York Central Railroad
Jackson, Michigan

North American Extrusion Corp.
P. O. Box 406, N. Riverview Drive
Parchment, Michigan 49004

Northern Michigan Electric Co-op
Boyne City, Michigan 49712

Northport Cherry Factory, Inc.
Northport, Michigan 49670

Onekama Canning Company
Onekama, Michigan 49675

Ott Chemical Company
500 Agard Road, Box 153
Muskegon, Michigan 49445

Owens-Illinois Glass Company
Charlotte, Michigan 48813

Packaging Corporation of America
American Box Board Division
Filer City, Michigan 49634

Packaging Corporation of America
American Box Board Division
Chicago Drive
Grandville, Michigan 49418

Packaging Corporation of America
Grand Rapids Caron Division
1957 Beverly, S.W.
Grand Rapids, Michigan 49509

Paris Gravel Company
20151 Coolidge Road
Big Rapids, Michigan 49307

Parke-Davis and Company
188 Howard
Holland, Michigan 49423

Parsons Corporation
Box 112
Traverse City, Michigan 49684

Pearl Grange Packing Company
44 City Market
Benton Harbor, Michigan 49022

Penn-Dixie Cement Corporation
438 East Lake Street
Petoskey, Michigan 49770

Pet Milk Company
118 Main
Coopersville, Michigan 49404

Pet Milk Company
652 Elm
Wayland, Michigan 49348

Pet Milk Company
Musselman Division
32 Lakeshore Division
St. Joseph, Michigan 49085

Pet Milk Company
Musselman-Dwan Division
S. Kalamazoo
Paw Paw, Michigan 49079

Pet Milk Company
Pet-Ritz Food Division
1121 Main
Frankfort, Michigan 49635

Petoskey Plating Company
Petoskey, Michigan 49770

Pittsburg Forging Company
919 Amur Street
Jackson, Michigan 49203

Plainwell Canning and Preserving Company
East Bridge Street
Plainwell, Michigan 49080

Quality Frozen Foods
Lawrence, Michigan 49064

Quincy Products Company
Division Stubnitz-Greene Corporation
50 South Main
Quincy, Michigan 49082

J. E. VOGT

Ralston Purina Company
Box 197, 150 South McCamly Street
Battle Creek, Michigan 49014

Rapid River Cheese Company
Rapid River, Michigan 49879

Remus Cooperative Creamery Company
Amble, Michigan 49329

Research Molding and Film Company
RFD No. 1
Mendon, Michigan 49072

Rex Paper Company
P.O. Box 751, Kings Highway
Kalamazoo, Michigan 49001

Rockford Paper Mills, Inc.
7734 Childsdale Road, N.E.
Rockford, Michigan 49341

Rockwell-Standard Corporation
Universal Joint Division
1 Glass Street
Allegan, Michigan 49010

Rudy Manufacturing Company
415 East Prairie Ronde Street
Dowagiac, Michigan 49047

Samary Food Products
150 West Randall
Coopersville, Michigan 49404

Sanders Packing Company
Custer, Michigan 49405

Saranac Milk Company
Saranac, Michigan 48881

Schaefer Manufacturing Company, Inc.
101 North Broadway
Union City, Michigan 49094

Schmidt Packing Company
P.O. Box 227
Niles, Michigan 49120

Scott Paper Company
Menominee Groundwood Mill
Menominee, Michigan 49858

Sealed Power Corporation
2001 Sanford Street
Muskegon Heights, Michigan 49444

Shakespeare Corporation
241 East Kalamazoo Street
Kalamazoo, Michigan 49006

Sill Farms Market
Route No. 1
Lawrence, Michigan 49064

Silver Mill Frozen Foods, Inc.
Old Pipestone Road, Box 155
Eau Claire, Michigan 49111

Simplicity Pattern Company, Inc.
901 Wayne Street
Niles, Michigan 49120

Simpson Lee Paper Company
Vicksburg, Michigan 49097

Smeltzer Packing Company
Benzonia, Michigan 49616

South Haven Chemical Company
Foot of Broadway
South Haven, Michigan 49090

Speas Company
Fremont, Michigan 49412

Standard Lime and Stone Company
Manistee, Michigan 49660

Stokely-Van Camp, Inc.
605 East State Street
Scottville, Michigan 49454

Stokely-Van Camp, Inc.
409 Wood
Hart, Michigan 49420

Store-A-Way, Inc.
DeWitt, Michigan 48820

Traverse City Canning Company
8th and Lake Avenue
Traverse City, Michigan 49684

Union Steel Products Company
504 North Berrien
Albion, Michigan 49224

Upjohn Company
7000 Portage
Kalamazoo, Michigan 49002

United Foods, Inc.
Sodus Fruit Division
Sodus, Michigan 49126

Universal Metal Products
Leigh Products, Inc.
Main Street
Saranac, Michigan 48881

Valley Metal Products Co.
800 East Bridge Street
Plainwell, Michigan 49080

Waldorf Paper Products Company
Mac Sim Bar Division
Box 187, 431 Helen
Otsego, Michigan 49078

Wallace Stone Company
Hersey, Michigan 49639

Warren, S. D. Company
2400 Lakeshore Drive
Muskegon, Michigan 49443

Watervliet Paper Company
279 Paw Paw
Watervliet, Michigan 49098

Welch Grape Juice Company
Lincoln
Lawton, Michigan 49065

Weyerhaeuser Company
White Pigeon, Michigan   49099

Weyerhaeuser Company
111 Mill
Plainwell, Michigan   49080

Whirlpool Corporation
Benton Harbor, Michigan   49022

Whitehall Leather Company
Division of Genesco
Whitehall, Michigan   49461

Whitehouse Milk Company, Inc.
Stephenson, Michigan   49887

White Products Corporation
Lafayette Street
Middleville, Michigan   49333

Wolverine Finishes Corp,
836-50 Chicago Drive, S.W.
Grand Rapids, Michigan   49509

Wolverine World Wide, Inc.
123 North Main
Rockford, Michigan   49341

Zeeland Poultry Processing Company
406 West Washington
Zeeland, Michigan   49464

Empire Iron Mining Company
Cleveland-Cliffs Iron Company
504 Spruce Street
Ishpeming, Michigan   49849

Leslie Metal Arts, Inc.
3225 32nd Street, S.E.
Grand Rapids, Michigan 49508

Utilex Corporation
425 Frank Street
Fowlerville, Michigan 48836

Withrow Pickle Company
Sand Lake, Michigan 49343

Mr. Hereford Garland, Director
Institute of Wood Research
Michigan Technological University
Houghton, Michigan

Andre L. Caron, Regional Engineer
National Council for Stream Improvement
Western Michigan University
Kalamazoo, Michigan 49001

Mr. Buford Nash, General Manager
& Vice President
Chesapeake and Ohio Railway
3044 West Grand Boulevard
Detroit, Michigan 48202

Mr. John W. Demcoe, Vice President
& General Manager
Grand Trunk Western Railroad
131 West Lafayette Boulevard
Detroit, Michigan 48226

Mr. C. L. Towle, President
Ann Arbor Railroad
13530 Michigan Avenue
Dearborn, Michigan 48121

Mr. Ben J. Pederson, General
Supervisor of Operations
Mackinac Transportation Company
214 East Hewitt
Marquette, Michigan

- - -

STATE OF MICHIGAN

PUBLIC SERVICE COMMISSION

To: Bill Walsh

From: Otto Sonefeld

RECEIVED
January 2, 1968
Water Resources
Commission

Per our conversation, I would suggest you contact the people on the attached list for any hearings or meetings on Lake Michigan pollution problems.

The Grand Trunk, C & O, and Ann Arbor all own and operate their own equipment. So does Mackinac Transportation Company except that it is jointly owned by Soo Line, New York Central and Pennsylvania Railroads. (Official office of MTC is in Detroit but Mr. Pederson is still the man to contact.)

Mr. Buford Nash, General Manager & Vice President Chesapeake and Ohio Railway 3044 West Grand Boulevard Detroit, Michigan 48202	Carferry service between Ludington and Milwaukee, Manitowac, and Kewaunee
Mr. John W. Demcoe, Vice President & General Manager Grand Truck Western Railroad 131 West Lafayette Boulevard Detroit, Michigan 48226	Carferry service between Muskegon and Milwaukee
Mr. C. L. Towle, President Ann Arbor Railroad 13530 Michigan Avenue Dearborn, Michigan 48121	Carferry Service between Elberta (Frankfort) and Manitowoc, Kewaunee, Menominee and Manistique
Mr. Ben J. Pederson, General Supervisor of Operations Mackinac Transportation Company 214 East Hewitt Marquette, Michigan	Carferry service between St. Ignace and Mackinaw City

Mr. Peter B. Spivak, Chairman
Michigan Public Service Commission
Lewis Cass Building
Lansing, Michigan 48913

Mr. Otto F. Sonefeld, Director
Railroad Division
Michigan Public Service Commission
Lewis Cass Building
Lansing, Michigan 48913

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MR. VOGT: The first person I would like to call is Dr. MacMullan, who is the Director of the Michigan Department of Conservation. We have copies of Dr. MacMullan's presentation which will be distributed very shortly to the Conferees.

DR. MAC MULLAN: Thank you, Mr. Vogt.

STATEMENT OF DR. RALPH A. MAC MULLAN DIRECTOR, MICHIGAN DEPARTMENT OF CONSERVATION TO FEDERAL CONFERENCE ON POLLUTION OF LAKE MICHIGAN AND ITS TRIBUTARY BASIN, CHICAGO, ILLINOIS,

FEBRUARY 6, 1968

DR. MAC MULLAN: Mr. Secretary, Conferees, Ladies and Gentlemen:

I am Dr. Ralph A. MacMullan, Director of the Michigan Department of Conservation. My department is responsible for the management of the natural resources of Michigan--its fish, its wildlife, its forests, its water, all its varied recreation resources. In the Department is the Water Resources Commission. Mr. Loring F. Oeming is Executive Secretary to the Commission and functions also as head of the Department Water Resources

Division. He is Michigan's designated official conferee at this conference.

In our Water Resources Commission, we have an effective instrument for pollution control. Its seven members include the directors of the Departments of Conservation, Public Health, State Highways and Agriculture, plus individuals representing the interests of industry, municipalities and conservation organizations. Thus, a broad spectrum of interests is brought to bear on pollution problems and on Commission decisions with respect to those problems. The system works very well.

We believe we have one of the best water pollution control programs in the Nation. Quite frankly, we think it is the best. Abetted by a strong pollution control law and backed by a public increasingly aware of and aroused about the importance of clean water, Michigan is keeping abreast of its water problems. We have not solved all of them, of course. In particular, our cities have not yet been able to finance all of the needed treatment facilities, although there is new hope in proposals, now before our Legislature, for substantial bond issues. However, we know what the needs are and where they are, and I am confident we will meet them with increasing speed.

Michigan pollution control program has been described in detail in our report presented to the conferees earlier in this conference. It is not my purpose to discuss the technical aspects of our pollution problems in Lake Michigan and the steps being taken to control them. Mr. Oeming and his assistants most certainly can do this with much greater expertise and depth of knowledge than I could. Rather, I would like to present to this conference some broad considerations of the importance of Lake Michigan as a recreation resource. I will also briefly discuss three specific problems which are of special concern to me as a natural resources administrator.

Michigan automobile license plates bear the slogan, "The Great Lake State," and our state is indeed in the center of the Great Lakes region. We exercise jurisdiction over 41 percent of all the Great Lakes, and over 58 percent--well over half--of the specific subject of this conference, Lake Michigan. In all, we "own" some 38,575 square miles of Great Lakes surface or, as former Michigan Governor Chas S. Osborn once so aptly put it, "two square miles of fresh, sweet water to every three square miles of land." About one-third, or 13,037 square miles, of that Michigan Great Lakes water is in Lake Michigan.

Michigan is one of the leading tourist states. In fact, tourism is our second-largest industry, topped only by manufacturing. It generates a business volume of at least a billion dollars annually. Thirty-five to 40 percent of our tourist traffic comes from out of state; indeed, much of it comes from our sister states represented at this conference. Michigan's standing as a tourist state is solidly based on her recreation attractions. People come to have fun and enjoy themselves in the out-of-doors. It is just plain good business, if nothing else, for us to keep our outdoors clean and attractive. And, of course, there are even more important reasons, as we all well know. Ultimately, the very existence of the human race depends upon a fit and habitable natural environment.

Some 4½ million visitors use our 15 state parks along the Lake Michigan shore each year. Untold other numbers avail themselves of the 214 miles of beaches and shoreline in public ownership. The volume of use of the 800 miles of privately owned shoreline is impossible to calculate.

Late last summer and fall, Lake Michigan took on an important new recreation role, which you will be hearing a lot more about in the years to come--that of a sportfishing center for coho salmon. I am sure you are at least generally aware of our salmon program, the truly remarkable initial success we have enjoyed, and the enthusiastic, almost crazy response of the public to this new recreation resource.

In Lake Michigan the tremendous population explosion of alewives is a symptom of the imbalance of present fish populations. The attendant massive alewife die-offs brought into focus the need to re-establish a proper balance of prey and predator species. It might be said that our salmon program developed out of a pollution problem. Those of you here in Chicago who have been exposed to the sight and stench of millions of dead alewives littering your beaches and clogging your water intakes will know what I mean when I call the alewife a pollution problem. We have it in Michigan, too, on a massive scale. It cost our tourist industry an estimated

55 million dollars in lost business last year alone. People just couldn't stand the stink, and went elsewhere.

A substantial alewife die-off may occur again next summer. Governor Romney has requested a supplemental appropriation from the Michigan Legislature to provide standby funds for a cooperative state-local alewife control and clean-up program.

While dead alewives are obviously a serious nuisance problem, live alewives can be an extremely valuable resource. This is particularly true if they can be converted through the food chain into more valuable and desirable game fish species.

The coho and also the chinook salmon we are stocking in Lake Michigan, along with lake trout and other species, feed on alewives. Once a proper ecological balance between these predators and their alewife prey is established, the alewife problem will come under control. That should happen in the relatively near future, if all continues to go well. It is unfortunate that more solutions to pollution problems cannot be achieved with such happy and productive fringe benefits.

It is belaboring the obvious for me to

state that most outdoor recreation today is water-oriented, and that water for recreation must be clean water. We are fond of saying that water which is suitable for all types of recreation, including swimming, is by definition suitable for all other types of use. We firmly believe that it should be our objective to preserve the quality of Lake Michigan water up to recreational standards. We recognize that there are and will continue to be difficulties in meeting those standards in certain parts of the lake, particularly in the vast urban-industrial complex at the south end. Nevertheless, we are convinced that this is the goal we should be shooting for.

Lake Michigan lies within a day's drive of more than 50 million people, and it draws them like a magnet. As its sportfishing potential increases, as the proposed Sleeping Bear Dunes National Lakeshore is established (and I am convinced it must be), as its other recreation potentials are more fully developed, it will draw more and more visitors.

Already, a significant number of our Lake Michigan swimming beaches have moderate to severe algae problems during the summer months. It is hypothesized that the recently reported phenomenon of an outbreak of diatoms and filamentous algae in the lower half of the lake is related to an influx of nutrients--phosphates and nitrates--flowing into the lake from tributary streams, as well as from wastes discharged directly into the lake. The methods of sewage treatment in general use today do not remove these nutrients. Here is an instance where we must apply better technology to solve a problem which meanwhile is likely to become increasingly serious.

Now, I would like to address myself to three specific problems which cannot be cured simply by better methods of sewage treatment.

The first of these is thermal pollution. Production of thermonuclear electric power in the United States is expected to increase by more than 60 times--60 times--in the next twelve years. The Wall Street Journal reported recently that "Lake Michigan alone may have at least 10 giant nuclear stations on its shore by the mid-1970's." There is one plant in operation, one under construction, and one on the drawing boards--all on Lake Michigan--at the present time. Thermonuclear plants require enormous volumes of water for cooling, and in the process that water is heated to high temperatures before it is discharged. One moderate-sized plant presently under investigation would use half a billion gallons each day and elevate the temperature 28 degrees (F).

What will be the effect if we permit the equivalent of 10 hugh hot-water rivers to flow into Lake Michigan? We frankly don't know. I suggest that we ought to be finding out, and we ought to be aware of the probable consequences before we go any farther with this kind of development. Otherwise, we may find out the hard way--after it is too late.

There seems to be some question whether or not such massive inputs of heat will mean an increasing elevation of annual lake temperature.

And I see after I prepared this manuscript that in your report, the Federal Government Report, that you estimate that this is not going to be a sizeable consideration, maybe in the range of a tenth of a degree. As a biologist, I can predict with some confidence that any permanent warming of Lake Michigan, even if very slight, will have widespread ecological effects. It could change the biological patterns of the lake, and even though we are not concerned, apparently, that this is going to be a problem, I would like to point out that we do feel, that we are concerned, that some widespread problems could result from this even to changing the climate, and so forth and so on, on a sizeable portion of the eastern side of Lake Michigan where our prevailing westerly winds affect the rainfall very much as they come across Lake Michigan.

And we also would have a possibility of mean summer temperatures being increased. Certainly warming the water would hasten even more the eutrophication--or biological aging--of Lake Michigan, which is alleged to be proceeding at from 300 to 500 times its natural rate. Now, I don't want to seem to be using scare tactics by comparing Lake Michigan to Lake Erie, because the two lakes are very dissimilar. Lake Erie is shallow and has a relatively rapid flow-through time period; Lake Michigan is deep and has a very slow flow-through period. These latter conditions warrant extreme caution, however, in the disposition of any non-biodegradable wastes, because they are going to be in the lake for a long time; the water doesn't move much. The important thing is that what must be avoided at all costs is permitting the development of a highly eutrophic fringe around the edges of Lake Michigan. This would drastically curtail (if not even eliminate) its recreational use. Here we can, I'm sure, and we must apply the lessons that we have learned with Lake Erie with profit.

Senator Muskie of Maine has been endeavoring to make the Atomic Energy Commission face up to the fact that heat can be as much a pollutant as radioactivity, and should therefore be a concern of that Commission in its atomic energy licensing procedures. Of course, heat can also be of benefit, but nonetheless, we have to be concerned about what its effect will be.

Possible thermal effects fall into two possible categories, local and basin-wide, and into two types within those categories, short-term and long-range. It seems to me that evaluation and mitigation of any local effects should be an obligation of the research project developer, much as it is in hydro-power situations, but widespread ecological influences should be financed as a broad based industry-wide responsibility.

One possible solution to financing the industrial obligation might be to place a tax (based on volume of cooling water used) on each plant as it comes into production. Such a tax could be extremely small--and still yield sufficient revenues over the years to provide a substantial fund for environmental studies, mitigation of damages, and eventually enhancement of the environment which is or may be affected. We don't have any pat answer, and I am no expert on taxes, but surely this conference can and should address itself to this problem and recommend a solution.

There is another thing that is inherent in this concept, I think, and that is that it isn't just a matter of saying to industry, well, you are going to have to do this and that, and you are going to have to do more things. We have to fully appreciate that in this, as in any other kind of pollution, if we want clean water ultimately it goes back down to where the consumer, that is us, are going to have to pay for it. The margin of profit, if it could be squeezed any thinner it would have been, I think, and if it can be squeezed thinner it shall be, but these things that are going to cost money we are going to have to pay for, and this means you and I and Joe Doaks. So it is all right for us to say that we want these things. It is inferred automatically that we are willing to pay for them. And this Nation can pay for them.

second specific area of pollution which I believe this conference should explore is that of pesticides. And that is quite a bit closer to my heart. It is particularly gratifying to me to observe the attention which has been given already at this conference to this form of pollution by Senator Nelson and in the Federal Water Pollution Control Administration report on water problems in Lake Michigan. Last year, it was proposed to spray dieldrin in Michigan Berrien County, a tributary watershed of Lake Michigan, to control Japanese beetles. I opposed that application, and it has been postponed.

In evaluating pesticides, the two factors most important to an entomologist, toxicity and persistency, are the same ones which cause natural resources managers the greatest concern. Of the two, persistency poses the greatest environmental threat because of the increased likelihood that the pesticide will hit non-target organisms sometime through its life. The half-life of dieldrin in soil, for example, is more than eight years, and it is toxic at varying levels to a broad spectrum of organisms. It has affected guppies in the laboratory at concentrations as low as 1.8 parts per billion. Wisconsin researchers have analyzed fish which contained as high as 4.18 parts per million of dieldrin, or about 2,500 times the level which affected those laboratory guppies. Fish from Lake Michigan have been found to contain .25 to .3 parts per million of dieldrin. Whether that is a dangerous level we do not know. We can be sure that dieldrin is dangerous at some level to any form of fish or animal life.

DDT also has a very long half-life, and, of course, these half-lives vary according to conditions, but in DDT it may be from five to twenty years for half-life. Because of the concentration of DDT and other chlorinated hydrocarbons as they pass through the biological food chain, a residue level far below that lethal to any organism can ultimately prove totally destructive somewhere along the line. Levels in water may be concentrated 10-fold by algae, 10 to 100-fold by zooplankton, 1,000-fold by fish, and 20 to 100,000-fold by fish-eating birds. There seems little doubt, as an example, that this is one of the important reasons for the drastic decline in numbers of our national bird, the bald eagle.

Recent analyses of DDT residues in coho salmon and their eggs from Lake Michigan showed concentration in the fish flesh of from 1 to 5 parts per million and in the eggs of from 1 to 3 parts per million. Some coho fry hatched from eggs taken from Lake Michigan salmon last fall are showing typical symptoms of pesticide poisoning. We have had larger losses of these young fish in our hatcheries than we had anticipated. They are not yet catastrophic to our coho program, but they are serious. We cannot definitely say that pesticides are responsible, because some virus diseases of young fish have symptoms like those of pesticide poisoning. There are also possibilities of a deficiency of some chemical, like iodine or thiamin. We are having tests made to try to determine the exact cause.

Nonetheless, we have every reason to believe that pesticides are one of the prime suspects as a possibility.

The concentrations are very close to

those which have been shown to affect lake trout survival in some eastern lakes. And they actually exceed those which have been shown in British Columbia research to affect coho salmon under some conditions. We most certainly are close to the danger point. And we most certainly cannot stand a build-up.

And this, I think, is just about the nub of this problem here. Here we have automatically in a fish just newly introduced into Lake Michigan concentrations of DDT at a point which in other cases has been detrimental to the reproduction of fish. If we haven't learned in this Nation the lesson from this DDT, despite the great things that DDT did in its day, but if we haven't learned our lesson and if we are still going to be unaware and unthinking about what we do with even greater poisons, then I think that we ought to have our heads knocked together.

I believe that this conference should develop a plan to stringently control pesticides residues in the Lake Michigan basin, with particular emphasis on those chemicals which are relatively persistent or, as we have come to term them, "hard."

We have identified seven--DDT, dieldrin, aldrin, endrin, heptachlor, lindane, and chlordane--which we believe should be either banned entirely or used only under the most careful controls. And again I am not putting a timetable on this, but this should be our goal. Malathion, methoxychlor and other relatively non-persistent chemicals provide acceptable substitutes, although more inconvenient, for most uses. And I am confident that we would be developing more and more as we go along. I am pleased to see the comments again in the Federal Water Pollution Control Report here calling for some supervision and monitoring and identification of the quantities of these. That is the first step.

Third and finally, I would like to discuss briefly the problem of oil discharges from shipping. I choose not to refer to them as "spills," because we doubt that they are very often accidental. Recently, 18 ships passed through the Detroit River and Lake St. Clair. Subsequently, an oil film was discovered which covered a vast portion of the lake and was moving down the river toward Lake Erie. The circumstances were such that the oil unquestionably came from one of those vessels. Yet despite efforts by our Water Resources investigators, the Federal Water Pollution Control Administration, the Coast Guard and Canada, the offender was not identified.

Last summer, an oil slick covering several square miles was reported in Lake Michigan. As far as I am aware, the cause was never determined.

These oil discharges can cause death to thousands of ducks and other waterfowl. They can cause secondary effects by destroying plants and other aquatic organisms upon which waterfowl and fish feed. They can result in tremendously expensive clean-up operations for boat owners, marina operators, and beach managers. They need not be of the magnitude of the Torrey Canyon disaster to have those effects.

The sooner these oil discharges are discovered, the greater the liklihood of determining the cause. I was pleased, therefore, by the plan of Mr. Paul Cannon, Chicago area manager of the Federal Aviation Administration, for reporting of oil slicks by commercial and private pilots. I would like to see this conference take a strong position in this matter, so that those responsible for such discharges can be identified and brought to account.

In conclusion, let me say that I believe this conference to be extremely timely. You may be sure that my Department will extend to you every possible assistance and support. I appreciate this opportunity to bring these matters to your attention.

Thank you, gentlemen.

MR. STEIN: Thank you.

(Off the record.)

MR. STEIN: May we get back on the record.

Are there any comments or questions of Dr. MacMullan?

Yes, Mr. Poston.

MR. POSTON: I appreciated very much Dr. MacMullan's concern for pesticides. To us this has been a problem that is very difficult to get a handle on and to have definite recommendations as to what ought to be done.

One of the things in which I was interested, whether he has any suggestions as to whether or not there might be state legislation for licensing or total prohibition, how he might suggest that this could be handled.

DR. MAC MULLAN: Mr. Poston, we are talking on that subject in Michigan right now. Two or three things are involved.

First there are certain chemicals which we think we ought to stop using just as quickly as we can, and this, of course, is a very controversial subject, but I would suggest right now, I think without too much contradiction from any of the quarters who are involved, that DDT is particularly virulent and that it can almost always be replaced by something else.

Secondly, we have the problem of -- well, that is one thing.

There are some other things, like dieldrin, for example, which is a particularly nasty one, we think, and we should work very quickly toward eliminating the use of that, I think, almost entirely.

Secondly, there is a large area that we can operate in to solve this problem by regulating the use of these things. I think of an example of a poured concrete basement wall in an institution that serves food, for example, where you have an ant problem. There one of the most dastardly chemicals could be used probably with safety within that confine if the material were completely safeguarded from getting into the environment.

Ideally, if we could find a chemical, the best pesticide that I would endorse would be extremely persistent, because that is one of the best qualifications of a pesticide, if it were completely able to kill one target organism that you wanted to. Then you have got the ideal.

So that persistency in itself is not bad. Persistency is bad because of the non-target organisms it hits. So, we have that second problem of very careful regulation of even the most potent chemicals.

The third problem, as I see it, is a very general and difficult one to get at and that is the indiscriminate use--and by that I don't mean the professionals at all, because they are discriminate--but the indiscriminate use by the innocent housewife or rose gardener who dumps a thousand times as much chemical, perhaps innocently, on his garden than he needs to, and this contributes to this load, this pesticide load, unwittingly. You can't expect the housewife to read the fine print. I can't even understand those organic compounds that are put on the can of a buzz bomb. So we have this problem of regulating for the people, just like the food and drug does, what things are safe to use and what aren't.

Our approach in Michigan at this time is to, through legislation, try to set up a board, something more than an advisory board, which has the responsibility for determining when and how these things are to be used. And I think it might be very similar to the Water Resources Commission, where they decide when and what can be done.

If we had this board and if it were a well-constructed board representing all people concerned, it should have the authority to say when and when not all governmental agencies, right down to townships and villages, and so on, would use these pesticides; and I would give it another authority if I had my way about it: they would also have the responsibility and the authority to regulate the licensing of individuals.

For example, I think that we are at a point now where, I'll bet you before I get kicked out of my job that we are going to have some of these things eliminated, like DDT and others, the actual elimination of those which are the most nasty.

And lastly, I have to end up on an optimistic note, that with this technology we have, I don't think we are very far away from developing chemicals to use to do these very worthwhile jobs that have to be done much more safely. I think we laugh about my ideal pesticide, but I think we will come to it some day or very closely to it.

And in that same line, I think again, just like in pollution control, we have to have a steady pressure, not an unwielding pressure, we have to have a steady pressure to move this way, just as this conference is doing here, because if we don't we will do things like we did with the race situation where we sit for a hundred years after we fought a civil war to solve it.

We have to push. We have a responsibility as government leaders to see that we move forward steadily and reasonably, but we have to do this.

MR. STEIN: Thank you, Dr. MacMullan.

Are there any further comments or questions?

MR. KLASSEN: I would just like to ask a question, Mr. Chairman.

Does Michigan control the application of herbicides and pesticides that the farmer, not the professional, but the farmer applies? If so, I would be interested to know how you control this. This is a difficult problem.

DR. MAC MULLAN: No, we don't have any control. As a matter of fact, there are some gentlemen here who can correct me if I am wrong on this, our control amounts principally to licensing the applicator, for a crop duster or something like that, and we don't have any regulations on the farmer or on the housewife.

I would like to say a word in defense of the farmer, though, because I am accused sometimes of being a little bit inconsiderate of him. The unconscious pressure of the agricultural people has done a lot, probably more than anyone else, to come along with developing new uses and better chemicals. So we have this pressure of the industry itself.

A good example is the use of DDT to spray for Dutch Elm disease. Now, in our Michigan State

University, in cooperation with our Department of Agriculture, this problem of using so much DDT in municipalities -- and this is probably one of the large major sources of infection -- we now have a system whereby we use methoxychloride with a helicoptor, a technique which is not unreasonable, in fact the price may be similar. This thing was developed without any law or anything, and this was a good move.

But I think that if we can regulate very carefully the use by state agencies and all governmental agencies, this will be a big example and then we will be able to point the finger a whole lot more at the other uses which may be indiscriminate.

And secondly, I am very glad to see the recommendation here that at least we know county by county how much we are putting on. I am quite concerned about Lake Michigan because we are surrounded by fruit country and there have been very harsh chemicals used on the fruit orchards and this may be one of the greater sources to Lake Michigan.

MR. KLASSEN: Mr. Chairman, this is real interesting. While we have a man here that knows this, I would like to ask a couple more questions.

In Illinois approximately 15 percent of the application is done by these professionals that you are controlling. The other 85 percent, we figure, comes from the individual farmer. I just wanted to ask if this same general figure applies to Michigan.

And secondly, I was interested in your comment that you were glad to see in this Federal Recommendation that there would be a county by county reporting or recording. Could you tell me so far -- I am asking this as we need this information -- the second question, how you would go about in Michigan, which would also apply to Illinois, to get this amount that is being applied county by county from the individual farmer if you have no control over him? I am asking for information.

DR. MAC MULLAN: Well, to answer your second question first, I don't have any idea that I can give you right here about how to do that. That is a tremendously difficult job. It would certainly have to be done by some kind of a sampling. But all I am doing here is endorsing wholeheartedly the idea that we should identify this problem.

I have talked to some of my friends in Agriculture who say that when we found this out we would be surprised at how little it is because the farmers themselves have developed better techniques, and, of course, no farmer wants to spend money for pesticides that aren't going to do him some good.

I think it can be done, it would have to be done on a sampling basis and it might not be able to be done on a county-by-county basis. But we have had more difficult problems that we have solved before, so I would just dismiss that and say that the statisticians and agriculturists can do this, at least give us a better idea.

To answer your first question about what percent the farmers are guilty of, I have been talking again to my agricultural friends and wondering if we could identify what percent is by the housewife, what percent is by the farmer, what percent is by governmental agencies, and I think the answer is, because we have been through it back and forth, we don't know. We have had a couple of studies. One study I am aware of in Red Cedar River, I believe, said that about 70 percent of it, Ralph, was through municipal drains, something like that. But again, this is a very typical area.

I think that one of the largest sources is run-off on streets from settled communities going through municipal sewage disposal plants, and this I am very optimistic about because this is something that we have a better way of controlling, perhaps. This is another figure that I think it would be worth our while to find out.

MR. KLASSEN: We don't agree with that in Illinois. We have had some studies made by the State Water Survey in the chain of lakes, I don't want to belabor this point, but it shows, and I think this is pretty much the country over, not only this country but other countries, that a very large percentage comes from agricultural run-off, particularly, and this will show that I am not a farmer but have many farmer friends that tell me that if they get a rain within 24 hours after they make an application of fertilizer they lose from 60 to 70 percent in their run-off into the streams.

DR. MAC MULLAN: Well, that may be true, Mr. Klassen. I am not familiar with that.

MR. STEIN: A point in there, and I think this is well taken, is Mr. Biglane here? Just to be sure. Down in Louisiana where they were using endrin on, oh, I guess they were using it on the sugar cane and on cotton, when we got a fast run-off the local conditions in the bayous were absolutely devastating; even relatively large animals in the bayous, the reptiles, were just wiped out. And I think that is fairly well documented. I don't think there is any doubt.

Another thing we found there was that when a commercial sprayer would go up, what they would do is just run the airplane over a field and if a little stream were there they would apply the pesticide to the stream as well as the field; this was the simple thing to do, and you got a big dose coming in that way. And I think with some of those you can, possibly with education or building ditches and being careful of the run-off, a lot of this can be prevented.

DR. MAC MULLAN: Mr. Stein, that would be a fourth area that we might move forward in.

I didn't mention it deliberately because I think we have come so far along that line.

In Michigan, for example, and there are other people who know more about this than I, I think we have been so concerned that our actual mechanics of application are pretty tightly regulated and that again is something that is relatively easy to take care of.

MR. STEIN: Thank you very much.

Are there any further comments or questions?

(No response.)

MR. STEIN: If not, I think we will call on Mr. Klassen now.

Mr. Klassen.

ILLINOIS PRESENTATION (CONTINUED)

MR. KLASSEN: Mr. Chairman, due to the cooperation of my fellow Conferees, we have kept delaying because of the inability of President Egan of the Metropolitan Sanitary District to be here for the last several days. He is with us this morning, and with the concurrence of my Conferees I am going to call on President John

Egan of the Metropolitan Sanitary District of Chicago.

STATEMENT OF JOHN E. EGAN,
PRESIDENT, METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

MR. EGAN: Mr. Chairman, gentlemen of the Conference, distinguished guests, ladies and gentlemen, and the members of the Sanitary District of Greater Chicago:

There was a time, and it has not been too long ago, when I might have been a trifle self-conscious about standing up here and talking to a gathering like this. There was a time when a good many of you, or at least the organizations you represent, had some fairly harsh things to say about the Metropolitan Sanitary District of Greater Chicago.

But on this happy occasion, I feel absolutely certain that we're all friends, we're all here for the same purpose, to protect the health and well-being and the enjoyment of the people who live in the states bordering on Lake Michigan.

Ever since the Sanitary District was

organized back in 1889, more than three quarters of a century ago, we have been active in fighting pollution of Lake Michigan. Consequently, we can lay some claim to being pioneers in the battle which brings us together this morning.

Lots of water has flowed--opposite the usual direction, I might add--down the Chicago River since our war against contamination and pollution began. In the course of this battle, the Metropolitan Sanitary District of Greater Chicago has been sued, we have been enjoined, we have been estopped, we have been condemned, we have been restrained. We have been hamstrung and interfered with and persecuted in all of the thousand and one ways known to men and their lawyers. But our heads are still unbowed and we're still heart and soul with you in this fight that will take our united action to win.

One of the recent contributions to the battle was made by the Metropolitan Sanitary District of Greater Chicago last October. Through the good offices of Congressman John Kluczynski and many of his colleagues in both Houses, the trustees were able to present at a Congressional hearing our protest against the dumping of dredgings in Lake Michigan. The Army Corps of Engineers was most cooperative and ordered the dumping stopped.

Every time I say, "The Metropolitan Sanitary District of Greater Chicago," I realize what a mouthful it is. Perhaps I should take time out for a moment or two and explain just why we have been so identified by such a long title.

We were originally organized by the State Legislature in 1889 as the Sanitary District of Chicago. But today and for the past several decades we have functioned as a "Multi-Municipality" that includes Chicago and 114 distinct communities. We protect the water supply of some five and one half-million souls through the collection and treatment of sewage.

And now for a bit of a confession:

If we have been in the vanguard of the battle against this problem, Chicago has also been one of the very first to be guilty of water pollution. Our corporate guilt goes back to the days when we dug our first sewers and began dumping our waste matter into the lake. To avoid pumping this same waste matter back into the domestic water system, the city dug water intake tunnels into the lake. In time, these tunnels had to be extended farther and farther as the volume of waste got greater and greater.

We can probably date our real awakening to the dreadful situation facing us on August 2, 1885. That was the day of a record-breaking rainfall of some six inches. That was the day when the residents of the city turned on their water faucets and foul sewage poured out.

That was the day Chicago realized at last that something drastic had to be done to correct a condition that was causing citizens to absorb cholera, typhoid and dysentery germs with their drinking water, diseases which at the time caused fifty out of each thousand deaths every year.

The Sanitary District has come a long way since that day. How far we have come can best be summed up in the words of Dr. Luther Terry, former U.S. Surgeon General and head of the U.S. Public Health Service:

"Today Chicago has one of the best, most efficient, and most superbly maintained waste treatment plants in the whole world. The modern complex of facilities treats the waste of five million people and thousands of industries every day."

Another citation we all like to quote is from the American Society of Civil Engineers, who termed the Sanitary District "One of the Seven Wonders of American Engineering."

What have we done to deserve this?

Well, we've invested something more than a half-billion dollars in this "complex of facilities," including one of the finest research laboratories in the world built at a cost of over two million dollars.

We maintain 71 miles of navigable canals linking the Great Lakes-St. Lawrence Seaway with the inland waterway system to the Gulf of Mexico.

We maintain some 400 miles of intercepting sewers. We collect and treat one billion 250 million gallons of sewage every day.

We operate the largest sewage treatment plant in the world.

And you all know about the feat that played what was perhaps the most important part in our fight against waterborne diseases. This was the construction of the 28-mile Sanitary and Ship Canal and a system of locks.

Even though we now offer primary and secondary treatment of our sewage, and we are well on the way to completion of tertiary treatment, this flow of water away from Lake Michigan has not been without its trials and tribulations. It has caused considerable criticism and some rather harsh words and a good deal of legal action that I mentioned lightly a few moments ago. But all of that sort of thing, I trust, is water over the dam--over the Brandon Road dam at Joliet, to localize the figure of speech.

In spite of the trials and tribulations we have suffered, regardless of the accolades that have come our way for our successes, believe me, ladies and gentlemen, every single one of us involved with the Sanitary District realizes that we have still a lot to learn. We know full well that it is only by pooling our collective experience and by working together with all of you that we can hope to prevent the disaster which stares us in the face. And it is a disaster which threatens our very lives, as well as the full enjoyment that Lake Michigan can bring to all of us in the years to come.

The communities served by all of us here today, this vast and constantly growing Midwest Megalopolis, still have a serious fight on our hands, a fight that is literally for survival, a fight that actually goes back to those biblical times when Moses laid down the law of sanitation for the wandering Isrealites.

But I must raise a question, a question which, I am sure, will not meet with popular response:

DO WE HAVE THE ANSWER?

We at the Sanitary District thought that we had the answer in 1900 when we reversed the Chicago River.

We thought we had the answer when we built the world's largest sewage treatment plant.

We again thought we had the answer when we erected the largest installation of the Zimpro process.

We have investigated a great many proposals of late, but, frankly, we do not know the answer. And in the course of reading the papers that have been presented at this conference, I have serious doubts as to where the solution lies.

Is there enough money available--yes, even Federal money--to do the job for even Lake Michigan alone?

It seems to me that if this gathering of knowledgeable and dedicated people has revealed anything, it has disclosed the need for a radically new approach to the problem. Model T methods just aren't effective in a "jet" society. We can't wait ten or twenty years for presently known methods to be implemented. We must come up with something that will do the job NOW, and by that I mean within the next four to five years.

I hate to face the prospect, but even that time may not be enough in which to save the lake.

It seems to me that we must take every step we can to curtail further pollution by known methods right now. But, in the meantime, we must turn to our universities and our other research facilities to zero in on this job. We must do what we did when we needed an atom bomb. We must organize every resource of science and man's energy to come up with a practical, workable answer. We need a new Manhattan Project and we need it now!

Much as I dislike to conclude on this pessimistic note, I think it would be a misleading and tragic course to pursue if we did not readily admit that while our discussions have delineated the problem, it now remains for us to find a solution.

And when and if we find a solution it will not only save Lake Michigan, but end the growing fears of men all over the globe who are beginning to realize their survival depends on the answer.

It is a fight that can be and will be won by sessions like this today, accompanied by our firm and high resolution to fight shoulder to shoulder for this, our common cause.

MR. STEIN: Thank you, President Egan, for a very comprehensive and provocative statement.

Are there any comments or questions?

Speaking for the Federal Program, President Egan has been one of the most forward-

Looking and cooperative Water Pollution Control administrators in the country on any level, and I think if we had men like President Egan we could show that this complicated problem of Federal, State, municipal and industrial cooperative relationships can work.

I would like to just say one thing. One of the other major cities in the country was in Washington the other week with a considerable delegation arguing with us about our requirement that they upgrade their treatment plant, and the answer was, "For a large city in the country we provide the best treatment. Why are you bugging us?"

And I said, "You do? Are you going to take on Chicago?"

So he said, "No, we have to discount Chicago."

MR. EGAN: Thank you, Mr. Stein.

MR. STEIN: Thank you.

(Applause.)

MR. STEIN: Mr. Vogt.

MICHIGAN PRESENTATION (CONTINUED)

MR. VOGT: Mr. Chairman, the next speaker that I would like to call for Michigan is Mr. John Calkins. He is the Chief Deputy Director of the Michigan Department of Agriculture, and he will present Mr. Dale Ball's statement. Mr. Ball is the Director of Agriculture in Michigan.

We are also passing out at this time copies of Mr. Calkins' statement.

STATEMENT BEFORE FEDERAL CONFERENCE
ON POLLUTION OF LAKE MICHIGAN AND ITS
TRIBUTARY BASIN, CHICAGO, ILLINOIS,
February 6, 1968
BY B. DALE BALL, DIRECTOR, MICHIGAN
DEPARTMENT OF AGRICULTURE

PRESENTED BY JOHN CALKINS, CHIEF
DEPUTY DIRECTOR, MICHIGAN DEPARTMENT
OF AGRICULTURE

MR. CALKINS: Thank you, Chairman Stein. Mr. Vogt, Conferees, ladies and gentlemen:

The Michigan Department of Agriculture

is closely involved in the management of Michigan natural resources, including those specific aspects of natural resources management which are the concern of this conference.

The Director of Agriculture is a member of the State Water Resources Commission, the Air Pollution Control Commission, and is chairman of the State Soil Conservation Committee. The Director of Agriculture is chairman of the drainage boards for all of the more than 1,000 established inter-county drains within the state.

A major responsibility of the Michigan Department of Agriculture is in consumer protection, guaranteeing the wholesomeness and sanitation of the food supply of Michigan's more than 8 million residents. But the department is also deeply involved in matters that affect the livalihood of 93,000 Michigan farm operators who control the management of more than 13 million acres of Michigan land area--about one-third of the total area of the state.

The record should note that Michigan farm land managers have made outstanding contributions in natural resources management. Substantial increases in food have been accomplished without increasing acreage.

A study of the Department of the Interior January 1968 report, "Action for Clean Water," reveals that probably three aspects of Michigan agriculture are of special concern to this conference. These are sedimentation, agricultural fertilizers, and agricultural pesticides.

While this report does not list sedimentation as a major area of concern, I think it deserves mention.

In Michigan, organized soil conservation districts are in operation in all but two of the state's 83 counties. Soil conservation districts are vitally concerned with sedimentation problems, and in every case a major portion of each district's efforts are directed to reducing soil erosion and resultant sedimentation. The leadership of Michigan 83 soil conservation districts is largely from agriculture.

Agriculture is only one of the factors involved in soil erosion. Major contributors are uncontrolled erosion from building sites, roads and stream banks. It is interesting to note that agricultural soil scientists set standards for soil erosion losses that are as much as 20 times less than known examples of erosion that is presently occurring in connection with building and construction sites.[1]

The report on water pollution problems that preceded this conference states that eutrophication is a threat to the usefulness of Lake Michigan and states this is due to several elements and that the element most amenable to control is phosphorous. About two-thirds of the present annual supply of phosphate going into Lake Michigan (estimated to be about 50 million pounds) comes from municipal and industrial wastes.

The other third is a composite of all non-point sources. An unknown fraction of this latter third is natural in origin. It gets into the water by leaching from soils and rocks on the watershed. One of the contributing factors, according to the report, is the residue from applications of phosphate-rich fertilizers to farm lands.

An interesting fact pointed out in this pre-conference report is that we know the source of two-thirds of the phosphate pollution going into

Lake Michigan--this is municipal and industrial waste waters. Wherever phosphate-bearing waters can be captured and put through a treatment plant, techniques are now available for removing a high percentage of the phosphate content at a reasonable cost.

In regard to phosphates originating in farm fertilizers, it is important to recognize the following facts:

(1) Agricultural fertilizers have contributed greatly to soil conservation.

(2) Phosphates in fertilizers are closely bonded into the soil and not readily subject to loss into watersheds. In fact, so closely bonded are phosphates that farmers must resort to banding fertilizer directly into the plant root areas.

(3) In today's agriculture, scientifically blended "custom" fertilizers are often applied according to a field prescription so as to minimize over-application of any elements involved.

(4) Agriculture in general is very

careful in application of fertilizers, which are an expensive item in farm production.

(5) The fraction of phosphate eutrophication contributed by agricultural fertilizers is as yet an unknown fraction of the one-third composite that is contributed by all sources other than municipal and industrial wastes.

Identifying these phosphate losses from agricultural fertilizers and developing methods of holding them to an absolute minimum is of real concern to agriculture.

When and if such losses can be identified and science comes up with better ways of keeping these expensive phosphates bound into the farmer's topsoil, there is no question that, without outside coercion, agriculture will take advantage of this knowledge. There has already been great progress in this direction.

Now, in regard to pesticides, even critics of pesticide usage admit that pesticides are a necessary tool in agriculture and natural resources management. Food shortages by 1984 have been predicted, even with the use of pesticides for a more productive agriculture. Agriculture is concerned that through public hysteria, aroused often by innuendo, agriculture will be robbed of one of its most important working tools.

As many of you know, representatives of Michigan agriculture were in court within the last few months to answer a citizen's suit concerning the use of certain pesticides. Much of the publicity surrounding this legal action involved innuendo, and the public was often hard-pressed to sort fact from fiction. The case involved the use of so-called "hard" pesticides, certain chlorinated hydrocarbons.

No segment of our society is more concerned with the proper use of "hard" pesticides than agriculture. Such pesticides are registered at the Federal level under standards developed jointly by the U.S. Department of Agriculture and the Department of Health, Education and Welfare. In Michigan, in addition to Federal registration, pesticides must have label registration by the Michigan Department of Agriculture, and we maintain one of the most modern laboratories in the Nation.

In the continual search for better methods of pest control, agriculture is in the forefront. Michigan State University has a nationwide reputation for leadership in this field. Right now MSU is fast developing the finest pesticide research facility in the entire Midwest and one of the finest to be found anywhere in the world.

Agriculture is in desperate need of reasonable finite tolerances for pesticide residues. Analytical technology has made such advances that we can measure down to a few parts per billion rather than to half a part per million considered as "zero" a few years ago. As a result, good and safe milk has been barred from the market and dumped for no reason other than the increasing sensitivity of our instruments.[2]

The substitution of finite tolerances for insignificant negligible residues, instead of a mathematical concept of zero, does not concern safety,[3] but it does concern our ability to feed ourselves at reasonable cost.

It is important that these answers be

provided, and not only from a public health standpoint; the controversy and atmosphere of uncertainty has delayed the correction of unnecessary restrictions and has discouraged industrial research efforts that might have been directed toward developing safer, more selective and more efficient pesticides.

There is interesting research on record that points up the vital need for more research and more facts before we make decisions that would have repercussions, not only throughout agriculture, but that would affect the present and future food supply of every citizen.

Specifically, may I refer to a recent study by a Michigan State University scientist. I believe Dr. MacMullan referred to this earlier. This study took place near my own backyard, along the Red Cedar River that runs through rich southern Michigan farm land and a number of communities, including my home town of East Lansing, Michigan.

This research, conducted by Dr. Matthew J. Zabik, involved collection of water samples throughout the season at 14 points along the Red Cedar River. Some of these points were adjacent to intensively used agricultural lands and some were below municipal sewage outlets. Dr. Zabik's study showed that 70 to 90 per cent of the pesticide pollution in the Red Cedar River comes from urban, not farm and rural, sources. He also found very little evidence of land wash contributing to the Red Cedar pollution problem.

Dr. Zabik stated that the key to cleaning up the river is to raise the level of treatment at sewage plants along the waterway so that more nutrients and other pollutants will be removed. He noted that tertiary treatment of this type would also significantly decrease the pesticide residue in the river, since much of it is carried by suspended matter. Dr. Zabik stated that it is currently "very, very difficult" to determine the exact effects pesticides have on aquatic life.

Another example that points up the need for more research in the area of chemical residues is a recent study indicating that certain chemicals, generally of urban or industrial origin and closely related to the so-called "hard" pesticides, have been detected in bird's livers and eggs in greater quantities than the organochlorine, or "hard", pesticide residues.

These compounds are polychlorobiphenyls closely associated with our common industrial and household plastics, and they are known to be toxic.[4]

The purpose of citing these last two examples is to establish the fact that until we know more about the sources of chemical pollution and their effect upon man and his environment, the scientific implications of pesticide residue tolerances, and the means to definitely measure and identify these residues, we must proceed with reason and caution in developing workable guidelines for the use of pesticides. It does not make sense to outlaw all uses of chlorinated hydrocarbons. And I would like to say right here that the Michigan Department of Agriculture has curtailed its use of "hard" pesticides in many, many areas, even though we did use or did plan to use dieldrin this last fall to control an infestation of Japanese Beetles. The record will show that we have greatly decreased our use of it and we are substituting other pesticides for the use of DDT and some of the other "hard" pesticides. But there are sensible and responsible uses for these tools, the hard pesticides, in natural resources management.

Agriculture has demonstrated it is willing to follow sound scientific guidelines established in the areas of erosion control, fertilizer application and pesticide usage.

The facts will prove that Michigan is taking aggressive action in the area of water conservation:

...Our pesticide research facilities are among the best in the world.

...Soil conservation districts are active in soil and water management throughout the state.

...Governor Romney has recommended a billion dollar program to reduce pollution in Michigan, including a $335 million state bonding provision.

...The Michigan Water Resources Commission is now carrying out and will continue to carry out a comprehensive program of pollution abatement to protect and preserve the quality of Lake Michigan water.

Thank you.

JOHN CALKINS

BIBLIOGRAPHY

1. "The Effect of Urbanization on Sedimentation in the Clinton River Basin," University of Michigan, July 1967.

2. Committee on Appropriations, House of Representatives, Report of the Surveys and Investigations Staff, National Agricultural Chemicals Association, reprint pages 17 and 18, 1965.

3. National Academy of Science, Report of the Pesticide Residues Committee, 1965.

4. "Chlorinated Hydrocarbons in British Wildlife," NATURE Magazine, October 21, 1967, pages 227-229.

MR. STEIN: Thank you, Mr. Calkins.

Are there any comments or questions?

(No response.)

MR. STEIN: I would like to point out one aspect of your paper which I agreed with, and I think this is a very important one as long as it is brought up and might save everyone a good deal of time, and that is that zero tolerance controversy. The notion of someone saying that you can't have any of any specific material or if you find any in there leads to some very peculiar results. What this means in practice is we use existing techniques, and, for example, if they can detect with using existing techniques down to five parts per million, if that testing doesn't show any material like that, the product is considered to be reasonably safe and is out on the market. This technique is just as good until the next bright young boy comes up with an improved technique and instead of five parts per million will find five parts per billion, and suddenly all these products which were on the market and everyone was using that didn't seem to cause anyone harm suddenly become unsafe and we run into a controversy. Then what happens, in a year or two someone comes up and finds out how to detect the stuff down to five parts per trillion and we are in this operation all over again.

So I think we have to not be too glib or get ourselves involved with something which we think is a poison and talk about zero tolerance and we are not going to have any of this, because while that has been done in the past, it has led to a lot of fruitless controversy that has had to be resolved. I think Mr. Calkins is right, we have to come up with finite numbers or perhaps we can provide a kind of escape hatch. This zero tolerance technique is not the one that works, and I think this has been fairly well demonstrated.

Thank you very much.

Mr. Vogt.

MR. VOGT: The next presentation will be by Dr. Peter I. Tack on behalf of the Michigan Association of Conservation Ecologists.

We are now passing to the Conferees copies of the remainder of the presentations, so please keep them handy.

THE POSITION OF THE MICHIGAN ASSOCIATION OF CONSERVATION ECOLOGISTS ON LAKE MICHIGAN EUTROPHICATION

BY

PETER I. TACK, CHAIRMAN AND PROFESSOR
DEPARTMENT OF FISHERIES AND WILDLIFE
PROFESSOR OF ZOOLOGY
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN
PRESENTED FEBRUARY 6, 1968
MICHIGAN ASSOCIATION OF CONSERVATION ECOLOGISTS MEETING
CHICAGO, ILLINOIS

P. I. TACK

DR. TACK: Mr. Chairman, Conferees, ladies and gentlemen:

INTRODUCTION

I have been asked by the President of the Michigan Association of Conservation Ecologists to present the position of this organization on the pollution of Lake Michigan.

In order to save time, in going over the name of this organization I will use the initials M-A-C-E and simply pronounce it MACE.

MACE is an organization of practicing environmental scientists and allied administrators whose membership embraces the great majority of the competent experience in observation of the decline of quality of the aquatic environment in Michigan.

It is my purpose at this Conference to proclaim the deep concern of the members of this organization about the rapid decline of water quality in Lake Michigan. This lake, with its 22,400 square miles of surface, 1,661 miles of shoreline, and large volume of formerly high quality water is a large and important segment of human environment. The size of this segment alone demands our very best efforts to preserve it in its cleanest possible state.

Among the most important economic considerations is that of public water supplies for many municipalities. This reason also commands our best efforts. There are, of course, many other reasons. Perhaps the most pressing demand for cleaning and preserving the water quality of Lake Michigan is economic.

While little effort has been devoted to compiling the economic value of this resource, this value may be hinted at through the losses experienced by Michigan communities along Lake Michigan as a result of the alewife mortality of 1967 and the ensuing odors which drove away vacationists. The Michigan Tourist and Resort Council has estimated this loss alone as 55 million dollars.

THE CONCERNS OF MACE

The rapid increase in the apparent effects of eutrophication on water quality in Lake Michigan is one of the most urgent causes for concern. The evident blooms of blue-green algae are unmistakeable indicators of enrichment of this environment, which has long been characterized by cold, clean, transparent water. These algae require certain minimal levels of mineral nutrients to sustain populations which may be described as a bloom. These nutrients have evidently been increased in abundance to the point where these blooms may be sustained. Estimates of the contributions of mineral nutrients have been made for at least some tributary streams. These estimates are impressive in view of the known ability of these algae to respond vigorously to minute changes in level of such nutrients as phosphorous.

Not all of the pollution problems arise out of eutrophication, however. The presence of appreciable amounts of pesticides in this environment are cause for grave concern. The amounts of pesticides in fishes from Lake Michigan are now approaching levels where they may be expected to affect population levels and success of restoration of fishes to Lake Michigan. While cause and effect relationships have not been firmly established, the high mortalities occurring among the coho fry at the time they cease their dependence on stored yolk and start feeding on natural foods are suspected to result from the relatively high pesticide burdens of these fishes. This suspicion is not casual or capricious. There is enough scientific evidence to cause deep concern.

The continuing presence of type E botulism toxins in Lake Michigan must also be viewed with concern. Eutrophication of the Lake water is implicated in the presence of this toxin. This toxin is produced only in the absence of oxygen or the presence of very small amounts of oxygen. This condition may occur where the oxygen is reduced by organic wastes or dead alewives which also provide a protein base on which the organism can grow. The prospect of increased warming of Lake Michigan waters in the near future, as a result of thermonuclear power plants now under construction, can also be expected to make the cleanup of these waters more difficult. The higher temperature will increase growth of algae, bacteria, and similar organisms and may be expected to heighten the decrease of oxygen and the production of botulism toxin. The vast amount of heat planned to be added to Lake Michigan is cause for deep concern.

There are, of course, many other reasons for urging action to clean up these waters. The aesthetic reasons cannot be denied in a society that has become acutely aware of the quality of their environment and which demands an improved quality habitat in which to live.

THE URGENCY OF THE PROBLEM

The Michigan Association of Conservation Ecologists wishes to emphasize the urgency of this problem. We request immediate arrangements for organized and concerted action to rehabilitate these waters. Any deferment of action will have long-range effects on water quality. The levels of mineral nutrients now in the Lake will sustain appreciable algae blooms for many years since these minerals are recycled many times through successive generations of algae, animals which live on algae, ending ultimately in fish. The very long period of residence of water in Lake Michigan will also insure the long term residence of these nutrients. It may be unrealistic to expect instantaneous or sharp reductions in the amount of mineral material entering the Lake, but every effort should be made to insure such reduction as quickly as possible.

P. I. TACK

The entire history of the battle for clean water has been characterized by its slow gains. The losses generally have exceeded the gains by a substantial margin. This has been true even where the size of the water involved was infinitesimal in comparison with Lake Michigan. The magnitude of this job is enormous, and little experience is available for guidance in a work of this magnitude. There are also many governmental agencies and subdivisions involved, which complicates the approach greatly. These obstacles to progress are not cited to overawe or discourage those involved, but are given to emphasize the need for immediate and concerted action.

FURTHER ACTIONS WHICH SHOULD BE TAKEN

Many positive and progressive steps can be taken at an early date to improve the quality of water entering Lake Michigan through its many tributaries. Among the first of these steps should be the setting of realistic goals for achieving interstate water quality standards. These goals should be set and announced with maximum participation of state and local governmental units and

P. I. TACK

their agencies. Each community's part in achieving these improvement goals should be delineated so the magnitude of individual jobs may be readily comprehended. Among the specific steps which may be taken would be the formation of local, watershed, state and regional citizens committees to focus attention on jobs to be done at each level. Jobs which are in need of this kind of attention are the anticipation of the approach to capacity of local waste water treatment plants, correlating widespread information on such topics as thermal pollution, and relating progress and problems to the public. This would permit the development of public support for increasing the capacity of treatment plants before the pollution of receiving streams becomes intolerable.

Watershed committees should assist in coordinating public support for water improvement on an area basis. State and regional committees should assist in the broader coordination of problems and progress, as well as in the development of support for bonding and appropriations issues. There is great need for public support at every level of government if progress is to be made in improving quality of water in Lake Michigan. The public appears to be demanding improved environmental quality, but the translation of this demand into action over so wide an area as the watershed of Lake Michigan will require a great and concerted effort involving the best leadership at every level.

AWARENESS OF PROGRESS BEING MADE

In focusing on what needs to be done to improve this vast segment of environment, the tendency is to overlook or discount progress of the past or present. We do not wish to do this. The efforts to reduce or remove phosphates from detergents should be applauded and encouraged in every possible way. So also should the progress being made in reducing the pollution from pleasure craft on our public water be applauded and supported. Many localities and industries are taking steps to control their own waste disposal problems. These are encouraging signs of public support for this environmental improvement surge.

FINANCIAL SUPPORT

The cost of any program to clean up Lake Michigan will ultimately fall on the citizen either through taxes, increased cost of goods and services, loss of recreational places, or a combination of these. It is, therefore, with a clear conscience that we urge bonding and taxing programs to finance the proposed clean-up program. The cost of such a program will be great, and they will need to be spread over long periods of time.

EDUCATION NEEDED

Finally, there is a great need for a coordinated and cooperative educational enterprise associated with this program. Many of the pollutional problems now being encountered never should have arisen. The selection of different alternative methods of waste disposal could have avoided many problems. The recovery of many waste products has in the past proved profitable, but were adopted reluctantly.

Further progress in developing profitable uses for waste products should be vigorously pursued.

The dissemination of information and knowledge about recovery of wastes is important and should be promoted. These are essentially educational processes, which are now of pitifully small proportions. Education is needed also to achieve support for the program. This support will be more easily won if a coordinated education program is instituted.

MR. STEIN: Thank you, Professor Tack.

Are there any comments or questions?

MR. VOGT: Mr. Chairman, I have a comment.

Dr. Tack, in the further actions which you are proposing that should be taken, I am sure that you are well aware that the first step in this series of actions that you have suggested has already been accomplished in Michigan in that water quality standards for the interstate waters have been adopted following many public hearings around the state and also a plan of implementation has been developed and the various water uses which are to be protected have also been defined following many public hearings, also following the suggestions that you have proposed here whereby citizens' groups have been involved in great depth. And I think that you are well aware of that.

DR. TACK: I am, sir, aware of that. My charge here is merely to urge that we proceed with these things vigorously and that we set realistic goals in achieving these standards. I realize we have plans, but achieving is another matter, and this is what we are urging.

MR. STEIN: Thank you.

Are there any further comments or questions?

That was a very thorough and thought-provoking statement. Very good.

Mr. Vogt.

MR. VOGT: The next appearance was to be by Mr. Leonard J. Goodsell, Executive Director of the Great Lakes Commission, but I believe the State of Illinois introduced Mr. Goodsell's statement in the record last Friday, because, of course, the Great Lakes Commission does include all of the states that are represented here in Illinois and introduced Mr. Goodsell's statement already, so we can pass that.

The next presentation will be by Mr. John Kennaugh of the Grand River Watershed Council.

John, copies of your presentation have been distributed to the Conferees.

MR. KENNAUGH: Thank you, John.

THE ROLE OF LOCAL COMMUNITIES TO COMBAT THE NATIONAL WATER POLLUTION PROBLEM

THE MICHIGAN GRAND RIVER WATERSHED COUNCIL
609 Prudden Building, Lansing, Michigan, 48933
JERROLD H. KEYWORTH, Chairman
JOHN H. KENNAUGH, Executive Secretary

MR. KENNAUGH: Mr. Chairman, Conferees, ladies and gentlemen: I am John H. Kennaugh, Executive Secretary of the Michigan Grand River Watershed Council, and you will note from our paper that this is a governmental entity representing the local communities throughout the Grand River watershed area.

It is my privilege to present on behalf of the Council our paper under the title, "The Role of Local Communities to Combat the National Water Pollution Problem."

THE WATER POLLUTION PROBLEM

Three significant factors are contributing to the water pollution problem in our streams and in our lakes. We all recognize these as PEOPLE, PROSPERITY and PRODUCTS. The State of Michigan is not unlike the other progressive states of our country. The population has increased three fold during the past sixty years and is projected to increase approximately two times by the turn of the century. Our prosperity has likewise changed, which is reflected in the changing water demands of our people. At the beginning of the century the domestic demand for water was five gallons per day per person. Today the people of our state are demanding 160 gallons per day and by the year 2015 A.D. this demand is projected to be 240 gallons per day per person. Needless to say, the demand for water further indicates the need for water to provide the products that are essential to meet the pace set by the increasing standard of living.

Pollution sources are varied in types and extent. The concern to control the pollution of water for DOMESTIC use did not occur until the ground and surface waters became a public health problem. A major contribution to the pollution problem was the advent of urbanization, which created the need for more intensive collection and disposal of human wastes. Michigan communities have developed lagoon systems, primary and secondary treatment plants. But it is apparent longer range plans need to be developed to meet the increasing demands for quality treatment to preserve our limited water resources. New products utilizing phosphate compounds is only one example of new wastes that are not removed by the standard treatment process. At the same time, our increasing demand for existing products and our cultural demand for new products is surpassing our present ability to maintain the ecological balance of our natural environment. Enlargement of existing facilities and provision for tertiary treatment will resolve many of these problems.

Disposal of INDUSTRIAL WASTES into our streams was once a practical solution to the problem of balancing equities between our natural resources and the economic stability of our communities. The balancing of equities now lies between preserving the limited natural resources as against the demands of the increasing population and the rapidly changing standard of living. Industrial pollution once involved the disposal of relatively simple chemical wastes and the normal domestic wastes. Increased production and development of new processes has placed greater strain on our waterways. Environmental control in modern industrial plants has caused more intensive heat exchange conditions in our streams and lakes and further contributes to the damages on our natural resources.

URBANIZATION around our major cities has also taken a toll from our natural resources. Intensive development for industrial parks, shopping plazas and residential areas has changed not only the topography of the land but has placed new values on the remaining natural resources. Lack of adequate controls on area-wide improvements has contributed to soil erosion problems. Increased land values are influencing the potential development of flood plains. Projections for surface water recreation indicate the demandswill triple by the turn of the century as compared to a doubling of the population. Intensified use of chemical products results in greater loadings of these wastes in our waterways. All of these factors have a deleterious effect on the natural characteristics of our streams and lakes.

AGRICULTURAL LAND MANAGEMENT has been emphasized for many years in order to save the soil for agricultural use. Greater emphasis is now required in order to protect the water courses as well as the land. Deforestation, intensified farming practices, utilization of marginal lands and residential development of farming areas have further contributed to the problem of runoff and soil erosion. Better products and methods for fertilizing have contributed significantly to the eutrophication of our streams and lakes. Intensive use of herbicides and pesticides to satisfy the agricultural and community needs on the one hand has, on the other hand, disturbed the natural balance of our environment.

WATER POLLUTION CONTROLS

At one time THE INDIVIDUAL was responsible for exercising his own controls on the use of his water resources. For the most part this required budgeting his supplies to meet his needs. Because of his nomadic habits, many of these needs could be satisfied by moving about. Pollution concerned him only as it disturbed his aesthetic appreciation of his resources.

Communal living allowed greater exchange of goods and capabilities, provided sustained stability for the new society, enhanced the cultural appreciation of the people, and created viable opportunities to further establish the social environment. Community efforts and goals were developed through various GOVERNMENTAL STRUCTURES. Community needs were satisfied through informal and formal cooperative effort. Intensified need for the use of the natural resources resulted in a further need to effectively manage the use of these resources and to preserve the unused resources. Communities were organized politically as townships, villages, cities and counties with the authority from the state to affect health, safety and welfare concerns of the community. The goals of the community were generally satisfied until the needs and concerns were changed from a local matter to regional, state and interstate matters.

Problems that could not be solved locally or problems that were a mutual concern of other municipalities became a matter for state resolution. Water and air are the most common elements of our environment. Unrestrained use of these elements will have a direct or indirect effect on others utilizing the same resources. Standard controls for using these resources on a regional basis has necessitated state intervention to protect the safety, health and welfare concerns for the people of the state.

Local pollution problems have become regional, state, interstate, national and international problems, because all flowing water relates the communities from the headwaters of the local watershed all the way to the sea. Water salinity, anadromous fish, ocean tides, drought and economic changes are no longer isolated problems affecting just a local area but are parts of a complex relationship between all people. FEDERAL intervention becomes paramount in resolving the far reaching problems beyond the limits of our local communities and states. The state is primarily responsible for protecting the health, safety and welfare of the people; however, the Federal Government is applying controls affecting local conditions through the administration of financial aid. Pollution control by the Federal Government has been effected through the administration of construction grants, award of research grants, conducting enforcement proceedings, sponsoring comprehensive planning, and encouraging the establishment of water quality standards.

An essential concept that cannot be overlooked is that our country is organized under a democratic form of government that has been created, "of the people, by the people, for the people."

Our RESPONSIBILITY AS INDIVIDUALS has enlarged from a local concern for our natural resources to a regional and national responsibility. While at one time we may have considered ourselves conservationists because of our efforts to effectively utilize our present resources, we now have to regard ourselves as stewards, or trustees, because we realize that none of these resources can be considered our private property, but will, at one time or another, become the property of someone else.

INVOLVEMENT OF GRASS ROOTS GOVERNMENT

The Michigan State Legislature dramatically stepped forward in 1964 when it adopted enabling legislation called the "Local River Management Act." The preamble states this is:

> "An act to enable local units of government to cooperate in planning and carrying out a coordinated water management program in the watershed which they share."

According to the provisions of the legislation, a Watershed Council may be formed to represent the governmental units in a river basin. The Council may then perform the following functions:

> "Conduct, or cause to be conducted, studies of the water resources of the watershed, including investigations of water uses, water quality and the reliability of the water resource.
>
> "Prepare periodic reports concerning, among other things, trends in water use and availability, emerging water problems and recommendations for appropriate public policies and programs necessary to maintain adequate water resources for the watershed area.
>
> "Request the Michigan Water Resources Commission to survey the watershed for the purpose of determining minimum levels of stream flow necessary for

> health, welfare and safety.
>
> "Advise agencies of federal, state and local governments as to the council's view of the watershed's problems and needs.
>
> "Cooperate with federal, state and local agencies in providing stream gauges, water quality sampling stations, or other water resource data-gathering facilities or programs that aid the council in its responsibility for studying and reporting on water conditions.
>
> "Establish special project funds as needed to finance special studies outside its annual budget capacity and for this purpose the council may accept gifts and grants from private individuals, corporations, and local, state or federal governments."

The MICHIGAN GRAND RIVER WATERSHED COUNCIL was organized June 1966. The Council serves on behalf of fifty-nine governmental units representing over one million people in an area of over 5570 square miles. Membership by the governmental units is voluntary, which presently includes fifty-two members.

The WATERSHED COUNCIL is comprised of representatives from the governmental units according to population. The WATERSHED COUNCIL elects its own Executive Committee and adopts its own program. Each representative is assigned to one of the following committees: Administrative Control Committee, Finance Control Committee, Water Quality Control Committee, Water Quantity Control Committee. Technical Advisory Committees may be created to investigate and report on specific projects.

The effectiveness of an organization is recognized by the vitality of its members. Action is the result of Planning and Implementation. The WATERSHED COUNCIL, through its Executive Committee and subcommittees have been actively involved leading to action programs, and I will identify a few.

TYPE II COMPREHENSIVE WATER RESOURCES PLANNING STUDY

The Grand River Basin was designated in 1963 by the Federal Government for a Type II study to be completed in 1969 at an estimated cost of $2,000,000. At the time the organizational structure for the study was created, there was no agency that could directly represent the local governmental units in the Grand River Basin.

Following the organization of the

MICHIGAN GRAND RIVER WATERSHED COUNCIL, Governor George Romney authorized this Council to advise and consult the State of Michigan at the Federal Coordinating Committee on behalf of the local governmental units. The representatives of the WATERSHED COUNCIL have actively participated in the planning process of the study. Periodic reports have been prepared regarding the progress of the program and the WATERSHED COUNCIL will actively participate in relating the contents of the final report to all governmental units, public agencies and other organizations. The WATERSHED COUNCIL also expects to serve a vital role in coordinating the efforts of the governmental units to implement the recommendations of the plan.

WEST MICHIGAN WATER SUPPLY STUDY

The WATERSHED COUNCIL considered the need to determine the availability of additional water supply for a twelve-county area on the west side of Michigan. A technical advisory committee was created to conduct a privately financed study to determine the feasibility of supplying Lake Michigan water to the twelve-county area.

FLOOD PLAIN PROTECTION

Flood damages in the Grand River Basin have been nominal to this date because of the limited development in the flood plain area. The trend in urbanization indicates the need to develop adequate controls to safeguard against unnecessary damages in the future and to assure minimal flooding conditions. On behalf of the governmental units, the WATERSHED COUNCIL has filed applications for flood plain studies to be conducted by the Corps of Engineers. The WATERSHED COUNCIL is also formulating control measures that can be incorporated by the municipalities in subdivision control ordinances, zoning ordinances, comprehensive plans and building control ordinances.

WATER QUALITY STREAM STANDARDS

The Water Resources Commission has adopted water quality stream standards to be applied to the intrastate streams. The WATERSHED COUNCIL has transmitted this information to all the governmental units in the basin and sponsored several informational meetings to assist public officials to understand the program. Each governmental unit has been requested to adopt a resolution designating their preferred stream use. These resolutions will be presented at the water quality hearing for advisory purposes to the Water Resources Commission.

STREAM MONITORING PROGRAM

Essential to enforcing quality standards on the streams in the Grand River Basin, a monitoring program will be required. To date there is no systematic way for collecting, analyzing and storing data on the water conditions of our streams. The WATERSHED COUNCIL is preparing plans to institute a program that will utilize the water technicians from the water treatment plants across the basin to collect, analyze and report the water conditions according to standard procedures. Reports have indicated that of the 2,700,000 lbs. of ortho phosphate (asP) entering Lake Michigan from Michigan streams, 1,153,000 lbs., over 42 percent is from the Grand River Basin. Other parameters will also be identified to assure effective control on stream quality according to the adopted standards.

SOIL EROSION CONTROLS

Sedimentation in the Grand River Basin streams is considered to be one of the major pollution factors. The WATERSHED COUNCIL is preparing soil erosion control data that can be used by property owners, developers and governmental units to prevent the unnecessary erosion of soil due to poor land management practices.

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The WATERSHED COUNCIL programs have revealed problem areas that exist in the Grand River Basin. Evaluation of these problems has required involvement by the members. Knowledge of problems by concerned people is the foundation for a planning process which determines desirable solutions and methods of implementation. LOCAL PARTICIPATION in the development of plans provides strong assurances the plan can be implemented. An essential step that can not be overlooked is the educational process of the grass root forces of the communities. Public acceptance is necessary and it remains a vital privilege in our democratic government.

The MICHIGAN GRAND RIVER WATERSHED COUNCIL is a statutory entity composed of and representing the governmental units in the Grand River Basin according to the "Local River Management Act." It functions:

> "to enable local units of government to cooperate in planning and carrying out a coordinated water management program in the watershed."

The WATERSHED COUNCIL is comprised of the grass root elements of the communities and provides them the opportunity to become involved in the planning aspects of a water management program and continue their involvement by carrying out the program. This involvement allows direct and personal relationships with state and Federal officials in the development of regional water management programs assuring that these programs shall be __"of the people, by the people, for the people."

The MICHIGAN GRAND RIVER WATERSHED COUNCIL recognizes the need for a united effort to preserve our water resources. The program of the WATERSHED COUNCIL has exemplified its concern and demonstrated its ability to involve the people in sharing in the responsibilities for preserving these water resources. The MICHIGAN GRAND RIVER WATERSHED COUNCIL dedicates its support to local, state and Federal agencies to abate pollution in our streams, lakes and Lake Michigan.

Thank you.

MR. STEIN: Thank you, Mr. Kennaugh. Are there any comments or questions?

MR. KLASSEN: Mr. Chairman.

MR. STEIN: Yes.

MR. KLASSEN: I would just like to ask a couple of questions, purely for information, because this is a real interesting approach and one that we have talked about and have come close to in several respects in Illinois.

I would just like to ask the speaker the following questions:

Do you have actually any authority to implement your plans?

And secondly, what are your official relationships, we'll say, with the Michigan Water Resources Council? Is it necessary that they receive approval from your agency, for example, on the additional 10 percent Federal grants and this type of thing?

I'm for a grass root approach like this, but being on a State level in Illinois, there is always the question whether you are merely a planning agency for cooperation or have some official status in connection with your own State government.

My second reason for asking this, I was born and raised and spent a good share of my life in the Grand River Basin, so I have a personal interest in it.

MR. KENNAUGH: Technically we are not a planning agency, but were organized to assist local communities in coordinating their planning efforts, nor are we a regulatory agency. This is a responsibility of the designated State agencies.

But we serve in an advisory capacity for them and for our local communities and for Federal agencies, only on an advisory basis.

MR. KLASSEN: Good. Thank you.

MR. STEIN: Thank you.

Are there any further comments or

questions?

(No response.)

MR. STEIN: If not, thank you very much, sir.

Mr. Vogt.

MR. VOGT: Mr. Chairman, I talked with Mr. Klassen regarding Mr. Goodsell's statement, and there is some question as to whether his statement was actually entered into the record by the State of Illinois.

Therefore, I should like to enter Mr. Goodsell's statement on behalf of Michigan for the record. Mr. Goodsell is the Executive Director of the Great Lakes Commission.

MR. STEIN: Without objection, this statement will be entered as if read.

MR. KLASSEN: Mr. Chairman, I also want to say, with headquarters at Ann Arbor, Michigan, and this is why I felt that Michigan should have the prerogative of introducing this.

MR. VOGT: Thank you, Mr. Klassen.

STATEMENT OF LEONARD J. GOODSELL

EXECUTIVE DIRECTOR

GREAT LAKES COMMISSION

L. J. GOODSELL

MR. GOODSELL: Mr. Chairman, ladies and gentlemen:

I am Leonard J. Goodsell, Executive Director, Great Lakes Commission, which is dedicated to the service of the eight states which border on the Great Lakes--Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin--on water resources matters.

Preserving and enhancing the quality of the waters of the Great Lakes basin has long been the concern and interest of the Great Lakes Commission. A few short years ago water quality wasn't considered to be a major problem in the Great Lakes. The lakes were considered by some to be unpollutable. Since its establishment by the states in 1955, the Great Lakes Commission has worked toward instituting water quality management programs. In 1964 we were successful in having the problem of pollution control referred to the International Joint Commission for study and surveillance. The gathering here today is indicative that water quality management can no longer be treated as an unwanted stepchild. It is admittedly a real and major problem and will require financial, educational, research and political input to effect its solution. The Great Lakes Commission believes we should continue to march, in an orderly and business-like manner, to conserve the waters of the Nation.

Please let me review the Federal Water Pollution Control legislation:

Federal Water Pollution Control Act of 1948, PL 84-660 - This is the first identifiable Federal program for water pollution control. The Act was limited in scope and was never implemented with adequate appropriation. Government's earlier role had been confined to the Rivers and Harbors Act of 1899, Public Health Service Act of 1912, and Oil Pollution Control Act of 1924.

1956 Amendments to the Federal Water Pollution Control Act of 1948 - Amendments established basic policy that water pollution problems are best solved at the local level; authorized grants to the States and interstate agencies for water pollution control agencies for water pollution control activities and grants for waste treatment plant construction; provided a system for Federal control; and encouraged interstate compacts for joint solution to common water problems.

Federal Water Pollution Control Act Amendments (1961), Pl 87-88 - Extended Federal Pollution abatement authority to all interstate and navigable waters; increased construction grants and encouraged research activities.

Water Quality Act of 1965, PL 89-234 - Provided for the adoption and enforcement of water quality standards for interstate waters and portions thereof. The Act set up a separate agency, Federal Water Pollution Control Administration as part of D/HEW (since transferred to D/Interior); increased construction grants and authorized research and development grants to develop ways of preventing the discharge of untreated wastes from storm sewers or combined storm-sanitary sewers.

Clean Waters Restoration Act (1966), PL 89-753 - Provided grants for coordinated river basin planning, increased research spending; extended grants for construction beyond June 30, 1967; and authorized appropriation for FY 68 of $450 million, $700 million for FY 69, $1.0 billion for FY 70, $1.25 billion for FY 71; provided increases in the percentage of Federal grants for necessary treatment works with a maximum Federal grant of 55 percent if a state takes full advantage of Federal incentives.

In compliance with the Water Quality Act of 1965, each of the Great Lakes States had, prior to June 30, 1967, adopted water quality criteria applicable to interstate waters or portions thereof within the State, and adopted plans for the implementation and enforcement of the water quality criteria adopted. These criteria and plans, when approved by the Secretary of the Interior, then becomes the water quality standards applicable to such interstate waters or portions thereof.

> Section 10 (b) of the Act states "Consistent with the policy of this Act, State and interstate action to abate pollution of interstate or navigable waters shall be encouraged and shall not, except as provided..., be displaced by Federal enforcement action."

I raise these points for information, because many of us believe that legislation dealing with pollution control was intended, and should be progressive in full compliance with the law when they adopted criteria and plans as provided for in the Water Quality Act of 1965, Section 10 (c).

The Notice of this Conference cites Section 10 (probably Subsection (d)) as the basis for calling this Conference.

Recent inquiry reveals that of the eight Great Lakes States that adopted criteria and plans in accordance with Section 10 (c) of the Act, as amended, only two have had, through the approval of the Secretary, standards established.

Questions arise: Does this Conference

indicate that the provisions of the Water Quality Act of 1965 are not adequate to do the job? What future actions and activities can we expect under Subsections (c) and (d) of Section 10 of the Act?

A Conference has been held on the pollution of the waters in the Calumet area and lower Lake Michigan, and control and abatement actions are underway. Possibly through this Conference we may be able to tie together and correlate the several actions now underway incidental and pertinent to the water quality management of Lake Michigan.

A second item, and I'm sure this is familiar, is, in accordance with Water Pollution Control Act, as amended, what can be expected in the way of Federal support funds for the water quality management program?

Previously, the authorization for appropriate amounts of money (under the Clean Waters Restoration Act of 1966) were outlined--$450 million for FY 68, $700 million for FY 69. For FY 68 Congress appropriated $203 million. The authorized total of $3.55 billion for construction of sewage treatment facilities spread over five years (FY 67 through FY 71) was considered to be a minimum figure for Federal participation. As of April 1967 it was estimated that 1,884 applications for construction grants were pending, with a total eligible cost amounting to $13 billion. If the Federal share amounts to 40 percent, the cost will be $5.2 billion; at 55 percent, the cost will be $7.15 billion. The actual Federal cost will be somewhere between these two figures. Funding at the full authorization level is not adequate to do the job.

A third item is the research effort to support the water quality management effort. The Water Pollution Control Act provides for sizable sums to conduct research. In the summer of 1965 the Department of the Interior announced that, in its experimentation to develop new uses of coal, it had developed a process, then in pilot plant stage, which uses coal as a filler material in sewage treatment. It was reported that the two-stage filter process would remove all suspended solids, reduce BOD by 70 percent to 90 percent, remove phosphates in excess of 70 percent, detergents by 90 percent. The process was described as being advantageous in that, in contrast to bio-oxidation systems, it does not produce nitrates from nitrogen compounds. The total in-plant time for the process was stated to be from two to four hours.

To my mind, if the facts I have are correct, here is one action directed primarily to the problem of making more use of coal (The coal used as the filter medium is fully usable for fuel, following its use in the filters), a constructive action that may point the way for a real breakthrough in the sewage treatment process.

I don't know to what extent this coal filtration process has progressed, but a successful process of this type would save the municipalities and industries of the lake region millions of dollars and may do a job that we're apparrently not doing too well now. Our research dollars should be applied to research of this nature.

To summarize my three points:

(1) For information, how are actions under Subsection (c) and (d), Section 10, of the Water Pollution Control Act, as amended, to be correlated and follow-on actions established?

(2) For information, what are the dollar and time schedules for the Federal water treatment facilities program? States, municipalities and private entities will wish to set their schedules accordingly.

(3) For recommendation, guide the research expenditures into developing treatment and handling facilities which will produce effluents of the quality desired, avoid the "quick-fix" solutions, and which can be applied on an economically sound basis.

In the final analysis, economic and political considerations will dictate how well we do in passing on clean waters to the generation to come.

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MR. VOGT: I should now like to call Mr. James Rouman, on behalf of the Michigan United Conservation Clubs.

Is Jim in the room?

(No response.)

MR. VOGT: Apparently Mr. Rouman is not here, Mr. Chairman. We do have a copy of his statement. Therefore, I should like to enter it just the same as if he had presented it.

MR. STEIN: Will he be here later?

MR. VOGT: There is some question. I really don't know whether he will or not. Would you suggest that we hold it temporarily?

MR. STEIN: Well, I tell you, let's go off the record here.

(Off the record.)

MR. STEIN: If he comes, we will let him read it.

MR. VOGT: I'm sure he would like to. He was here last week.

MR. STEIN: Right.

MR. VOGT: If he comes in later on today, we will give him an opportunity to present it.

MR. STEIN: Without objection, this will appear in the record as if read.

MR. VOGT: Thank you.

STATEMENT OF JAMES L. ROUMAN
EXECUTIVE DIRECTOR
MICHIGAN UNITED CONSERVATION CLUBS

I am James L. Rouman, Executive Director of the Michigan United Conservation Clubs, with headquarters located in Lansing, Michigan.

MUCC is a statewide, non-profit, non-government, non-partisan organization of Michigan citizens. It is composed of about 350 sportsmen and conservation-related clubs and individuals throughout the state, with a total membership of approximately 70,000.

We in MUCC have been greatly concerned about the deteriorating quality of the waters in the Great Lakes Basin and the need for careful protection by high standards in the setting of interstate water quality criteria; we have expressed this concern in hearings which have been held in our state.

We believe that the primary uses designated for these waters should be water-based recreation and the production of fish for sport and human food. While these uses do not preclude carefully controlled commercial uses, such as industrial cooling and navigation, we believe that the following practices create urgent problems and should be rapidly discontinued:

Industrial discharge of solids and oil;

Disposal of wastes high in oxygen demand and nutrients;

Accumulation of persistent poisons;

Filling in marshy or shallow water areas for "development."

For longer range consideration, we call attention to two other areas:

Heat loading from manufacturing process and generation of electric power.

Discharge or spill of oils and other wastes from commercial vessels.

DISCUSSION

While all of these items apply to all the Great Lakes, we believe the demand is most urgent on Lake Michigan because of the rapid growth of population and commerce in this watershed and the slow turnover of water in this portion of the Great Lakes river system.

To abate or avoid these problems, we urge that a policy be developed that would prohibit the discharge of solids into the lake or any tributaries along the lines indicated in the announcement made in 1967 by the Engineering Corps, Department of the Army, and that wherever possible, the dredging necessary to maintain harbor depths be done in such manner as to minimize the adverse effects on the lake by placing the spoils on shore; and further, that each State take steps to minimize erosion from construction of highways, housing and other developments.

From the algae growths that are appearing along the beaches and the tremendous increase in the volume of forage fishes, it is obvious that the nutrient levels in Lake Michigan are already quite high. With the burgeoning population in the Lake Michigan basin, much of which will be resident on or near the shores, we believe it is especially urgent that means of reducing oxygen demand and the nutrient load be attacked vigorously now.

We have rather fragmentary information on the quantities of persistent poisons now present in the lake. Available information indicates that the persistent chlorinated hydrocarbon insecticides have already reached levels that will produce profound changes in the ecology of the lake. The obvious effects on the reproductive capacities of salmon and trout need no discussion. These programs already command a great deal of general interest. More important, we believe, will be the effects on the basic food chain and on the bird populations in the lake basin, which may be more subtle but nontheless devastating. Some of these more subtle effects are already apparent in colonies of birds that nest in the Great Lakes basin area.

The discharge of heat from power generation and other industrial uses has a potential for markedly altering the character of the lake and the climate around it. Any appreciable increase in temperature of Lake Michigan combined with the already plentiful supply of nutrients has a potential for accelerating eutrophication and producing more rapid degradation of water quality. It seems to us that the differences between southern and northern Lake Michigan may now be due, in part, to the heat loading around the south end of the lake.

The additions in heat loading resulting from building of new steel plants and the ten thermonuclear generators planned or building on the lake could make a much more marked change in the lake. We urge that industry be made responsible for studies of the local effects of their heat load and that coordinated studies of the overall effect of the total heat load be projected for power generation and other industrial sources to provide a basis for some forecast as to the total effect of the temperature on the lake and its resulting effect on the climate.

In the past year, newspapers have reported two discharges of oil into the lakes with some reference to their adverse effects. One of these was discharge of oil from industrial sources, the other a spill or discharge from shipping. We urge that a mechanism for continuous monitoring of oil slicks be developed and put into practice as rapidly as possible so that these oil discharges can be discovered early, the damage minimized and the responsibility fixed on the offending party.

We feel we must comment on one other facet of the proposals that have been made for water use in various parts of the country. The concept of an industrial river, we believe, has no application in the Great Lakes Basin. One industrial river, discharging a maximum waste load, would in time extend to the whole river system. If we remind ourselves that Lake Michigan is just a wide deep place in a river system, we can see that any move to promote industrial rivers will eventually result in making Lake Michigan an industrial lake.

Finally, in the overall solution of these and other problems, we hope that the obvious solution will not be utilized. It would be relatively easy to divert the outfalls from many areas on the periphery of Lake Michigan to other watersheds. This, we believe, would compound the problems of the other watersheds and aggravate the difficulties arising from withdrawals from Lake Michigan by the reversing of river systems.

SUMMARY

We urge immediate consideration of the following:

1. Abatement of the discharge of solids

into the Lake Michigan system and filling by erosion.

2. Reduction in disposal of wastes high in oxygen demand and nutrients into Lake Michigan and its tributaries.

3. Curtailment of the use of persistent pesticides and the release of other poisons in the Lake Michigan watershed.

4. Steps to halt filling of shallow areas of the lake.

5. Initiation of studies on the effects of heat loading that will enable us to forecast the effects of various levels of heat loading on the waters and the climate.

6. A monitoring system to detect and trace discharge of oils.

7. Agreement on means to prohibit industrial classification of waters in the Lake Michigan watershed.

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MR. VOGT: I would now like to call on Mr. Keith Wilson, representing the National

Association of State Boating Law Administrators.

Mr. Wilson?

(No response.)

We might follow a similar procedure with Keith Wilson's statement, Mr. Chairman, and if he comes in later on today we will give him an opportunity to present it. If not, I would like to have it entered into the record as though it was presented.

MR. STEIN: I think, by the way, this is a very interesting statement, I have been going through this, and this should be read kind of carefully by the Conferees.

MR. VOGT: I have a letter from the Michigan Manufacturers' Association, and this is directed to the Honorable Stewart L. Udall and is signed by Mr. John C. McCurry, General Manager of MMA. I would like to enter this letter in the record.

MR. STEIN: This letter will be introduced into the record without objection.

MICHIGAN MANUFACTURERS' ASSOCIATION
JOHN C. MC CURRY, GENERAL MANAGER
DETROIT, MICHIGAN

J. C. MC CURRY

The Honorable Stewart L. Udall
Secretary of the Interior
Conference on The Pollution of the
 Waters of Lake Michigan
c/o Sherman House
Randolph & Clark Streets
Chicago, Illinois

Dear Mr. Secretary

On behalf of the Michigan Manufacturers Association, I appreciate the opportunity of submitting some brief comments to you in connection with the current Conference on "The Pollution of the Waters of Lake Michigan and Its Tributary Basin". The Association and its members recognize the importance of water, not only for industrial and commercial purposes but also for such individual purposes as home and recreational use. Michigan manufacturers recognize their responsibility to return their effluent in a condition and quality that does not cause injury to other users or impair other uses; given present day technological knowledge, developments, and processes. This recognition is attested to by the millions of dollars spent in recent years by Michigan industry voluntarily or to meet lawfully established criteria and standards.

Michigan has had effective water pollution control laws for approximately forty years. As conditions have changed and new problems have developed, these statutes have been updated. We believe Michigan today has laws on the books that effectively meet the challenge of the times.

Next in importance to an adequate and effective body of law is a calm, well-reasoned administration of such law. We believe that the Michigan agencies administering the state's water laws have done, are doing, and will continue to do an effective job in administration and enforcement. Administrative agencies have sought and, with few exceptions so far as industry is concerned, have secured voluntary cooperation and compliance. Much has been accomplished by this procedure. Sometimes it may seem to others that the process is cumbersome and time consuming. However, it has produced and will continue to produce results and the progress has been orderly. Too frequently difficult problems are attacked with an element of hysteria. Hysteria itself accomplishes little of lasting value and is conducive to costly mistakes. A sound, well-reasoned and logical approach offers the best and most effective method of solving water pollution problems. This is the course Michigan is following--and properly so.

Last June, the Michigan Water Resources Commission adopted, under the provisions of the Federal Water Quality Act of 1965, water quality standards and a plan of implementation and enforcement. Upon your approval of the plan, as submitted, Michigan, its citizens and its industries will have guidelines and criteria to meet and follow. As has been the case in the past, Michigan and its job providers will meet their responsibilities.

I thank you for the privilege of expressing by this means the opinions of Michigan Manufacturers' Association.

Very truly yours,

(Signed) J. C. McCurry

JOHN C. McCURRY
General Manager

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MR. VOGT: I would now like to call on

Mr. George Dlesk, who will present a statement on behalf of the Pulp and Paper Mills in the Michigan Portion of the Lake Michigan Basin.

GEORGE DLESK
SENIOR VICE PRESIDENT
PACKAGING CORPORATION OF AMERICA

MR. DLESK: Mr. Chairman, Members of the Conference and other distinguished guests, ladies and gentlemen:

I am George Dlesk, Senior Vice President, Pulp, Paper and Paperboard Division, Packaging Corporation of America. I have been asked to present the following statement:

This statement expresses the views of the sixteen companies who have signed it. They are all located in the Lake Michigan drainage basin, in the State of Michigan. It is made in response to an invitation by the Water Resources Commission of Michigan dated December 29, 1967. These companies represent approximately 98 percent of the 5,300 tons of the daily pulp and paper production in the Michigan portion of the basin. This is equivalent to over ten million pounds per day of paper or would be approximately two pounds per day for the five and a half million people in the basin area. The production represents a substantial contribution to the economy of Michigan.

This Statement is presented by members of an industry whose very life blood depends on sound conservation principles. Our primary raw materials are trees and water. Their renewal and enhancement are vital to our existence. And speaking of conservation, our industry collects and uses a tremendous amount of waste paper every year. Ours was the first major industry to form its own water improvement research organizations: the Pulp Manufacturers Research League, founded in 1938, and the National Council for Stream Improvement, founded in 1943, twenty-five years ago. As a result of our applied research and process refinements, the organic pollutional load per ton of production has been reduced some 70 percent over the last twenty years.

We urge that this Conference:

(1) Take into consideration that the Michigan Water Resources Commission (WRC) has had an increasingly effective pollution abatement

program over a period of many years. As a result of this program, evidence clearly shows that the basin rivers in the State of Michigan, such as the Kalamazoo River, have better water quality today than ten years ago; and better ten years ago than twenty years ago. The WRC has issued orders of determination against any polluter whenever technologically feasible methods of treatment would measurably benefit the receiving waters. The Water Quality Criteria, Enforcement and Implementation Plans submitted by the WRC to the FWPCA in accordance with the requirements of the 1965 Federal Water Quality Act insures that the WRC's Policy of enhancement of Michigan water quality will continue in the years ahead. In its recommendations, the Conference should rely heavily on the technical advice of the State water pollution control agencies in the Lake Michigan Basin.

2. Make only those recommendations which will produce a measurable improvement in the water quality of Lake Michigan. Emotionally or politically inspired recommendations by this Conference are not likely to stand up under the

hard realities of techological and economic feasibility. The recommendations must be both _effective_ and _realistic_.

3. Limit its recommendations to _inter_-state waters only. Based on the record of accomplishment, and the Water Quality Standards and implementation plans now under development for _intra_state waters by the Michigan WRC and other State agencies, the protection of these _intra_-state waters can most effectively remain under the exclusive authority of the individual States.

Respectfully submitted,

Michigan Carton Company - Battle Creek
Mead Corporation - Escanaba and Otsego
Allied Paper Corporation - Kalamazoo
Brown Company - Kalamazoo
Hawthorne Paper Company - Kalamazoo
Georgia Pacific Company - Kalamazoo
National Gypsum Company - Kalamazoo
American Can Company - Menominee
S. D. Warren - Muskegon
French Paper Company - Niles
Menasha Corporation - Otsego
Hammermill Paper Company - Watervliet
Simpson Lee Paper Company - Vicksburg
Rockford Paper Mills - Rockford
Weyerhaeuser Company -
Plainwell and White Pigeon
Packaging Corporation of America -
Filer City and Grand Rapids

We want to thank you for the opportunity to appear before you.

MR. STEIN: Thank you.

Are there any comments or questions?

MR. HOLMER: Mr. Chairman.

Mr. Dlesk, your third recommendation relates to the suggestion that this Conference limit its recommendations to interstate waters only and that the protection of these intrastate waters can most effectively remain under the exclusive authority of the States.

The problem that perplexes me is whether it is appropriate for the States to have different standards applied according to a different timetable with different degrees of water quality than those which apply to intrastate waters. In Wisconsin we have felt it appropriate to think in terms of intrastate standards that are strictly comparable with those which we have suggested for interstate waters.

What is the advantage of leaving these under the exclusive authority of the States?

MR. DLESK: Well, I agree that the framework has been established and that we are probably all working within the same relative arena. Probably the enforcement administration of the intrastate waters is the key that we would care to consider in this statement.

MR. STEIN: Maybe we can clarify this, and I do this just in the interest, I hope, of clarification, because I think the Congress has already made a determination.

A lot of these companies are old friends I think we have met in other areas of the country. I also thought we have dealt with them on a reasonable basis looking for measurable improvements, that we haven't had any emotionally or politically inspired recommendations.

I might say that the notions of what was reasonable and feasible have not always met the -- at least our views of that have not always had the unanimous agreement and enthusiastic support of a lot of the companies mentioned here. But, again, I would like to point out that I think we have always been able to work out an agreement and an accommodation in every case, whatever the philosophy was, and by and large I think we get along very well.

Now, this notion of intrastate waters can most effectively remain under the exclusive authority of the individual States. Under the present law we can come in on an intrastate problem if it is a navigable stream (and most waters are) on the request of the Governor.

Now, this has happened involving pulp and paper mills in the past. We right now have-- and many of these companies are represented there-- one in Puget Sound which we were called in by Governor Rossellini of Washington. The question here is if it is exclusively under intrastate water systems and the State feels it is a big problem, the Governor asks us in.

Now, we were also asked in on the Detroit River by Governor Swainson of Michigan. You did have and still do not one of the companies listed here but a pulp and paper company in that area. That company has agreed to a Michigan enforcement requirement to clean up and is moving ahead with the other industries.

So I do think that under the Federal law this notion of anything being under the exclusive authority of the individual States has been changed; that that doesn't exist anymore. We do need the governor's request to come in, but we can have Federal jurisdiction in an intrastate matter and we have been called in several times in cases involving pulp and paper mills.

Again, to point out to the audience, as far as I can see, we have never gone to court with a pulp and paper mill, and I agree with you, the challenge is to keep them in business and not put them out of business. As far as I know, the record will show that they are still thriving and in business after these pollution control cases.

MR. HOLMER: You may leave me even more confused than I was.

MR. STEIN: Right.

(Laughter.)

MR. HOLMER: The recommendation is that the recommendations from this Conference be limited to interstate waters, and there are quite a number of intrastate waters that are within the basin of Lake Michigan. If these are adopted by -- or if the Secretary after this Conference is concluded makes recommendations and they are not limited to interstate waters, they would be Federally enforceable without the request of the Governor, if I understand the procedure.

MR. STEIN: The only way we can enforce them is if discharge in an intrastate water affects water quality in an interstate water, and the only way we can move to enforce under our own jurisdiction, standards or no standards, is where the pollution in one state endangers the health or welfare of persons in another state.

If neither of those situations apply, we will need the request of the Governor of the State before we go in. In other words, there must be pollution of interstate waters and that pollution must endanger the health or welfare of persons in another state. The likelihood of your endangering health or welfare of persons in another state without pollution of interstate waters is not very likely except in that case where we can't go in. This doesn't affect you as it would shellfish cases. But these four states need not worry about that provision of the Federal law, I don't believe.

MR. HOLMER: I am sure we don't worry about the shellfish. But there has been considerable evidence in the report, in the pre-Conference report of the FWPCA, to demonstrate that pollution in the tributary streams does affect the health and welfare of all.

MR. STEIN: And in that case we would have -- now, I am talking theoretically and not in terms of a specific case. But I think the Federal law is clear on this. If you have a discharge from a tributary stream going into Lake Michigan and this affects the welfare of all the people around Lake Michigan and contributes to the eutrophication of the lake, assuming this is so, I would think there was no doubt that we would have Federal jurisdiction to go in and abate that pollution, no question.

Some people may argue that, but I think they can just argue. They are not going to prevail.

MR. HOLMER: Thank you.

MR. STEIN: Are there any further comments?

(No response.)

MR. STEIN: If not, Mr. Vogt.

MR. VOGT: The next appearance will be by Mr. A. R. Balden, Chairman of the Natural

Resources Committee of the Michigan Chamber of Commerce.

MR. STEIN: Thank you for coming up, Mr. Balden. And I am going to depart here, because here is an old friend.

Unless you think we just go out and criticize people for lack of pollution control, I am delighted that Mr. Balden is here because the Chrysler Corporation, with which he has been associated, in my experience has been one of the most forthright corporations in the United States in its pollution abatement program. They have not waited for State, Federal or local officials to come up and force them to do things, develop standards, develop criteria. They have put in the devices which they have believed on their own would do the job, and in a good many cases they have shown the way.

In that Detroit case, for example, that I pointed out, that we went into awhile ago, when we looked at the various polluters we found that Chrysler was doing a good job; and while we had recommendations to make about other cities and some thirty-three industries in the area, we didn't about Chrysler. They already were doing the job.

Mr. Balden, we are delighted to have you here and delighted to have a company like yours with a pollution policy such as you have represented here. Thank you.

MR. BALDEN: Thank you very much, Mr. Stein.

STATEMENT OF A. R. BALDEN
CHAIRMAN, NATURAL RESOURCES COMMITTEE
MICHIGAN CHAMBER OF COMMERCE

MR. BALDEN: Conferees, Ladies and Gentlemen:

My name is Al Balden and I am presently the chairman of the Natural Resources Committee of the Michigan State Chamber of Commerce. I have been a member of this committee since its inception in 1962 and have been particularly gratified to see the work of this fine organization in a leadership role to protect the natural resources of our State of Michigan.

To assure the continuation of these natural resources to the extent that they shall always be maintained at their optimum, the Michigan

State Chamber of Commerce has placed water pollution control, the utilization of water resources, the preservation of all of our resources, and air pollution control high on its priorities list in program planning.

In retrospect, looking back at the initial goals set up in 1962, it is with pleasure that we can count among our accomplishments the enactment of a practical yet firm water pollution control law, an effective air pollution law, and other laws that strengthen the state role in guiding its own destiny.

I would like at this point to digress from the script. There is another item that came to my attention and that is that two or three years ago when it became evident that the State of Michigan, the Water Resources Commission, was going to have to accelerate its activities in water pollution control and that in order to so accelerate these activities it would need a greatly enlarged staff, our Chamber of Commerce Natural Resources group took an active stand in helping obtain these funds.

We believe we have placed Michigan in a

leadership role among states by demonstrating that appropriate measures can be taken at a state level. This deomonstrates clearly that business and state government have common objectives in meeting problems of this nature and that they can and are working together harmoniously in meeting a serious problem.

I would like to point out, however, that it did take the leadership and initiative of the State Chamber to bring all industry and other segments of the economy together to assist the Water Resources Commission in taking the appropriate steps.

Members of our committee and other representatives of Michigan industry met many times in many hearings before the Water Resources Commission to assist in formulating effective criteria within the technical capability available to industry.

Thus, it was with considerable satisfaction that eventually the proposed standards were agreed to by all concerned and in June 1967 were submitted to the Secretary of the Interior for his approval.

Since that time, hearings have continued and enforcement orders are being issued to hundreds of communities and scores of industries, particularly those who have critical sewage problems.

In a confidential survey conducted by the State Chamber, it was revealed that almost every industry is engaged in some phase of improvement of their industrial waste treatment facilities, involving the expenditure of many millions of dollars in the very near future.

Through all of this steady progress, there is an understandable hesitancy on the part of some to effect final control until the state-adopted standards have the requisite approval of the Secretary of the Interior.

We are very happy to represent the industry of Michigan at this conference. We want to take this opportunity to offer our full cooperation and to promise our continued interest in correcting the pollution problems of Lake Michigan.

The critical need at the moment is to take away the atmosphere of uncertainty that hovers over us. This can be accomplished by the immediate Federal approval or disapproval (with reasons) of the submitted water quality standards.

We are pleased to note that while full approval of the standards has not been accomplished, conversations between the Federal Water Pollution Control Agency and the various states have been initiated. This conference will serve a positive purpose if it accelerates action leading to full agreement on the standards.

In the meantime, we are moving ahead on the establishment of intrastate standards in our state. Last August the time table was announced for hearings to assign water quality standards to designated water uses for intrastate waters. These hearings are to be completed in December. The standards are substantially the same as those involved in interstate waters and thus are affected by the same uncertainty until the basic parameters are approved by the Secretary of the Interior.

In order to accelerate pollution control in Michigan, Governor Romney has proposed a supplemental appropriation to implement a $14.4 million Federal-State-local pollution control program and $335 million in general obligation bonds to help finance long-range pollution control.

Among the proposals called for by the Governor are funds for sharing with Federal and local units of Government the cost of the construction of pollution treatment facilities.

I point this out to you to indicate that we mean business in Michigan and are progressing as rapidly as possible toward the timely elimination of pollution to Lake Michigan.

We have much to gain by this step. I should point out that the tremendous salmon and trout propagation program that we now have going for us depends on clean water. The fact that it exists today in our waters should encourage all of us to act promptly to assure that it continues to grow and to prosper. I submit that the alarmist, who would have us smothering in pollution within the next few years, has not yet visited our clear streams and the exciting waters of Lake Michigan.

I invite all of you to come up and go Coho salmon fishing sometime.

MR. STEIN: Thank you, Al.

Are there any comments or questions?

(No response.)

MR. STEIN: Thank you for a good statement.

(Off the record.)

MR. STEIN: With that we plan to recess for lunch, but let me give you the schedule. We will start at 1:30, and we expect that Governor Knowles will go on at 2:00. But we reserve the privilege of interrupting the speaker who is making his presentation when Governor Knowles arrives to give Governor Knowles the opportunity to stay with his schedule, and then we will take up with that speaker later.

We stand in recess until 1:30.

(Whereupon, at 11:55 a.m., a luncheon recess was taken.)

AFTERNOON SESSION

(1:30 p.m.)

MR. STEIN: May we reconvene?

Mr. Vogt?

MR. VOGT: Mr. Chairman, at this point I would like to call on Mr. Keith Chambers, representing the Southern Lake Michigan Fishermen's Co-Operative Association.

Keith Chambers.

STATEMENT OF KEITH CHAMBERS
SOUTHERN LAKE MICHIGAN FISHERMAN'S
CO-OP ASSOCIATION
SAUGATUCK, MICHIGAN

MR. CHAMBERS: I want to thank the Chairman and this Committee for allowing me to appear here today.

In the fifties of this century, Lake Michigan had alewives in alarmingly vast numbers. In the winter of 1959 and the spring of 1960, the alarmed few of us in the commercial fishing industry, had laws changed to allow trawling for the taking of these species.

KEITH CHAMBERS

All these changes that have taken place in the Great Lakes are not news or history to us. As I am the fifth generation in commercial fishing, that we know of, these changes affect our livelihood to the extent of how to operate, what type of equipment and for what species to fish.

Last year (1967) between Wisconsin and Michigan, trawlers have produced over 50 million pounds of alewives. They are being utilized in fish meal and the pet food industry. In the future, they may be used as protein concentrate.

This year's alewife die-off finally alarmed the Great Lakes States of pollution, to the point that we cannot turn away from the problem. What the public and other people cannot understand is that about nine times the amount of dead alewives washed on beaches, sank to the bottom of Lake Michigan to add further to the already alarming conditions of polluted Lake Michigan.

After this year's die-off of alewife, we encountered five feet of decaying alewives on the bottom of Lake Michigan in from sixty feet of water to ninety feet of water. In miles from shore, this would be about 2 miles to 3½ miles from shore on the Michigan State side of Lake Michigan. Each state would vary as far as miles because of greater or lesser slope of lake bottom near shore.

This committee already knows the importance of the effects that this amount of dead fish can do to our fresh water basin. This depth of water is very, very serious, as drinking water is taken from this area. Spawning beds are ruined for both sport and commercial species. Yachts and small boat enthusiasts relax and utilize this area.

Fishery managers from some states believe the Coho salmon, which preys on alewives, is the long-range solution for alewife control. This year, the State of Michigan sold over 1 million pounds of salmon that entered two rivers to spawn and die. Next year's estimated run or die-off is near or over 4 million pounds.

When enough salmon are planted to control the alewife, what figure will be projected to the annual die-off salmon is not talked about or thought about, but should be brought to your attention and also to the attention of the public. Are some people trying to trade one problem for another? Ecological balance is needed and has to be a must.

just as pollution control is a must.

In August 1967, we offered a solution for the floating dead alewives that would help stop tons and tons of dead alewives from reaching the beaches. This operation would use surface trawls instead of bottom trawls, which are used to catch live alewives. The surface trawls or seines would skim the surface to a depth of about twenty feet. This would skim the dead floating fish and a portion of the sinking ninety percent that nobody sees to a depth of twenty or more feet.

These past seven years we have been and are constantly improving and developing skills, knowledge, research, equipment, facilities, and markets. The marketing is the major problem, as the sales control the amount of alewives caught or produced. All of this has been done by Lake Michigan trawlers, Wisconsin and Michigan, at no cost to State or Federal governments.

I have some figures here that I didn't have entered here just to bring the point that this is not an operation that is a six-week period as some people have surmised. What I have done here, I have broken this down to a unit of effort. Now, this unit of effort that I am referring to is per hour. This per hour is the actual time that this net is being towed. This does not include time going to the fishing grounds or back.

1966, January, hourly average in poundage was 5,190 pounds per hour.

February was 2,120 pounds per hour.

March, 1,855 pounds per hour.

April, 2,800 pounds per hour.

May, 27,576 pounds per hour of effort.

June, 13,160.

July, 1,440.

August, 1,212 pounds.

September, 2,455.

October, 1,300.

November, 2,160 pounds.

December, 1,860 pounds.

I could go through. In '67 it has gone up somewhat.

If the same cooperation were received by the local commercial operators as is suggested to foreign vessels, we believe we could expand the fleet and catching ability to exceed the help which these foreign vessels could give. In addition, this would not require changes in the Federal Law.

I am also representing sixteen trawlers from Wisconsin. They have sixteen trawlers and in 1965 -- I am speaking just of the Wisconsin Trawlers at the moment--they produced 11 million pounds of alewife; in '66, 24 million pounds; '67, 35 million pounds. These figures are verified by the Wisconsin Conservation Department.

In the figures that I gave for our cooperative, this is just one vessel and these will be verified by the Bureau of Commercial Fisheries at Ann Arbor.

In 1968 the projected figure of the Wisconsin Trawlers is 45 million pounds. In fish that would probably be about a million or more.

This year this is what they anticipate. However, the fish meal plants have advised the fishermen that they can only pay 15 dollars per ton due to the low price of fish meal caused by heavy imports. At this price no Alewife will be caught in 1968 because the trawlers cannot fish at this price.

If no trawlers operate, there will be another 45 or more million pounds of alewife left to die and pollute the waters of Lake Michigan.

The trawlers listed in this booklet are 55-foot steel trawlers, modern in every respect, equipped with the latest electronic equipment, such as Fish Finders, Marine Radios, and Depth Sounders. All but one are of the modern Stern Ramp design. This fleet is second to none in its size range on the Great Lakes, the Gulf States or the Coast Trawlers.

The operators have from two to ten years experience and have the most efficient nets and equipment available. No Canadian trawlers are needed.

Pollution
AND THE
The Alewife Problem
In Lake Michigan

FACTS AND FIGURES
COMPILED BY WISCONSIN LICENSED TRAWLERS

AND SOME ANSWERS

January 1968

ROBERT ANGWALL
75 Bay Shore, Marinette Wisconsin
Telephone RE 2-2923

— representing the following Wisconsin Trawlers:

	Hold Capacity
ART SWAER, Oconto, Wisconsin — 3 boats	25 tons each
SUSIE Q FISH CO., Two Rivers, Wisconsin — 2 boats	25 tons each
RULEAU BROS., Cedar River, Michigan — 1 boat	25 tons
ROBERT ANGWALL, Marinette, Wisconsin — 1 boat	60 tons
OLE JOHNSON, Oconto, Wisconsin — 1 boat	25 tons
WILBUR REED, Oconto, Wisconsin — 1 boat	25 tons
FRANK LE CLAIR & SON, Two Rivers, Wisconsin 1 boat	25 tons

* * *

Facts and Figures

- In 1965 11 million pounds of Alewife were caught by Wisconsin Trawlers.
- In 1966 24 million pounds of Alewife were caught by Wisconsin Trawlers.
- In 1967 35 million pounds of Alewife were caught by Wisconsin Trawlers.

  The above figures can be verified at the Wisconsin Conservation Department, Green Bay, Wisconsin.

- In 1968 it would be projected that the Wisconsin Trawlers could produce 45 million pounds of Alewife or about 1 billion fish.

However the Fish Meal plants have advised the fishermen that they can only pay $15.00 per ton due to the low price of fish meal caused by heavy imports. At this price no Alewife will be caught in 1968 because the trawlers cannot fish at this price.

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☆

Answers to the Problems

Under the supervision and in coordination with the Bureau of Commercial Fisheries utilize the Wisconsin Trawlers to catch Alewife before they die off and before they drift onto the beaches.

Enter into Lease Agreements with the individual trawlers for fixed amounts. Items to be considered:

1. Disposal of fish caught.
2. Length of fishing day.
3. Areas to be fished.
4. Bottom trawling and surface skimming.
5. Dollar value of fixed amounts.

We have trucks available for each boat to transport these fish to market or wherever we have to go to dispose of them.

MR. CHAMBERS: I think that will be it, unless there are any questions.

MR. STEIN: Let me ask you, do you think that you have the equipment to seine all the alewives so we won't have a die-off if it could be made economically feasible for you and worth your while?

MR. CHAMBERS: This is really an unknown. We can project or produce figures of live alewives. The rate of floating or dying is another question. We feel with eight to ten boats that we could take care of a hundred mile strip or area, but this has not been done.

MR. STEIN: Here is what I am getting at. We had a tremendous alewife die-off on the beaches last year. Do you have the physical equipment to catch all these alewives, and let's suppose you received a subsidy or some money to help you with this, so they wouldn't be any nuisance on the beaches?

MR. CHAMBERS: I would say close to that, but there will be some nuisance. I wouldn't want to stand here and say that we could guarantee it. But if you produce another--now, not live ones, but the dead ones floating off the lake, if you took off 20 or 30 or 50 or 100 million pounds, this definitely has got to be a tremendous improvement.

MR. STEIN: Well, here, what I am doing is looking for some way so we won't have that die-off next year. Now, you say no Canadian trawlers are needed. If we get an estimate and we get the--if you don't have the capacity and we have Canadian trawlers, this may be a method of getting rid of the alewives, wouldn't it?

MR. CHAMBERS: There are boats that are not being utilized today. There is two, there have been two, large trawlers in the 75-foot class area that hold 60 tons that are not being used. These are owned by people in the Great Lakes.

MR. STEIN: But that is just two. What I am saying, do we have enough equipment to handle the Lake Michigan problem on the American side?

Let us suppose money were no object; we were to tell you to come up with a fair price. Could the American Trawler Fleet get enough boats into Lake Michigan to be reasonably sure we wouldn't have alewives littering the beaches this year?

MR. CHAMBERS: I believe there are other ways of doing it than by importing Canadian boats.

MR. STEIN: Like what?

MR. CHAMBERS: I think there are vessels in the United States Navy, for one example, that could be utilized.

MR. STEIN: No, I don't think -- let's look at this. Here is what I am thinking. What I am looking for is a reasonable method, and I am just exploring this, that we in the States can get together to get rid of these alewives so we won't be faced with the nuisance problem next year. Now, you have an American fishing fleet. I think we have to look to private enterprise for that. The question is--let me make this first assumption--with the boats available both from the Canadian and the American side you would have no doubt that we could seine enough alewives so we wouldn't have the problem, is that correct?

MR. CHAMBERS: Yes.

MR. STEIN: All right. Now, if this is the case, the question is, if we can't do it with the American fleet alone we have to determine where we can get it.

What would you think the cost would be to augment your costs so this could be the kind of enterprise--and I am not suggesting this, that we are going to do this, but I am exploring the possibility. Supposing the States and we wanted to get together and use the existing commercial fleets, giving preference, of course, to the American boats, but augmenting this with Canadian boats, how much would this cost us? How much would we have to put up in Federal funds and State funds or public funds to have you utilize this method so we wouldn't have this alewife nuisance?

MR. CHAMBERS: Well, this is a rather hard question to answer for two reasons. One of them is we do not know the number of days that this would be needed. Now, for an operation that these vessels cruise, they would have to be contracted by the day, not by the poundage, because we have no outlet for the poundage. So what we feel is just is 550 dollars a day. This is a vessel, the crew and the captain.

MR. STEIN: How much of this would have to come from public funds? For example, you are going to get some money for the alewife catch, aren't you?

MR. CHAMBERS: If there is a place for them. This is what controls our production now, the ready markets that we have control the production that we now have.

MR. STEIN: All right. Let me ask you, a boat would cost 550 dollars a day to control alewives?

MR. CHAMBERS: Yes.

MR. STEIN: All right. Now, how many boats do you think we would need? I am trying for a ballpark estimate here.

MR. CHAMBERS: There are twenty available--

MR. STEIN: No, how many boats do you think we would need to control the whole problem?

Let's suppose I had all the money in the world and I said to you, "Mr. Chambers, you get a fleet of boats and seine those alewives as they come up," how many boats would you think you would need?

MR. CHAMBERS: If you want me to be perfectly frank and honest --

MR. STEIN: Yes.

MR. CHAMBERS: --I don't know.

MR. STEIN: Well, if we are going to come up with this as a possible solution, and I think this has some intriguing possibilities, it is much better to seine those alewives, much better than bulldozing them off the beaches once they get on there. If we are thinking in terms of this -- in terms of an immediate public program to deal with this and are going to utilize your boats -- we are going to have to come up with some kind of cost estimates to see if this is feasible ---

MR. CHAMBERS: Right.

MR. STEIN: --- and if we have the resources to do it. I think you have raised a very, very interesting possibility. But I do believe we are going to have to have you people go home with our fishery experts and sharpen your pencils and see if we can come up with an estimate.

MR. CHAMBERS: Right. Now, we are here for a starting point. And this, I say, your twenty vessels that you now have is a starting point. This is what is going to prove your knowns and your unknowns, where at the moment I wouldn't say 40 would do it, maybe 20 can do it, maybe 10 can do it. I doubt it. I doubt it very much.

But I would say it is in the realm of 30 boats. I would say. But this is just a halfway educated guess.

MR. STEIN: Thirty boats would amount to what, about 15 thousand dollars a day? Right?

MR. CHAMBERS: In that realm, yes.

MR. STEIN: How many days would you think they would have to run to do the job?

MR. CHAMBERS: Well, we found last year it started when the run was tapering off, so that would have been from the first part of July through the middle of August--no, it wasn't. It was over by August, actually. We had Federal meetings in Muskegon August 3rd, and it was done. So it would be roughly around a four or five week period.

MR. STEIN: In other words, you would estimate that the clean-up program probably would cost about a half million dollars?

MR. CHAMBERS: Yes.

MR. STEIN: All right.

Now, again, if this is an estimate, we can come up with firm figures and put it to you with the resources of the four States and the Federal Government, and if we cannot have an alewife problem here with about a half a million dollar expenditure from public funds, this may be something very well that the Conferees may very carefully consider. But I think before we can entertain a proposition like that, we pretty much have to have cost figures and a kind of check from the Bureau of Commercial Fisheries and your State fisheries groups that this would reasonably do the job.

But it seems to me that what you are presenting here may be an avenue that we would seriously consider.

MR. HOLMER: It certainly so appears, Mr. Chairman.

But I have a preliminary question.

The last paragraph of your statement, Mr. Chambers, says, "If the same cooperation were received by the local commercial operators as is suggested to foreign vessels."

I wonder if you could elaborate a little bit as to what you mean by the same cooperation?

MR. CHAMBERS: Well, the articles that we have read within the past week, that the Government was going to lease these Canadian vessels and man them with American crews to get by this Federal curtailment. Well, being selfish, like all humans are, I would like this kind of a deal. I would rather lease my boat to the government and sit home and draw the same kind of money without endeavoring to work it or to earn your keep, so to speak.

MR. HOLMER: But this is what you meant by this statement?

MR. CHAMBERS: Well, I mean I am just bringing out a point here. This is, I think, a better deal for the Canadians than what it is for the Americans. This was the example I am using.

MR. STEIN: Before we get into it, I think what we have to do, and I don't think there is any question, at least I hope I am speaking for the Conferees--

MR. CHAMBERS: Could I interrupt here for just a moment? What I am trying to emphasize or bring out here is that when help is needed let's take care of what we already have first.

MR. STEIN: Sure.

MR. CHAMBERS: And from there on, let's see where we have to go.

MR. STEIN: I don't think there is any question here, and I don't know that I speak for all the Conferees, that at least the people at this table would prefer to use--after all, Lake Michigan is an American lake--we would prefer to use American equipment and American resources before we go somewhere else.

I think what we do need, though, is kind of a hard-nosed nuts and bolts proposition where we can determine what is needed and for how long to rid Lake Michigan of alewives or keep it under control. Secondly, how much it is going to cost. And thirdly, how much American equipment and American personnel we have available. And then if we have to augment that by a foreign source, we will do it.

But I think until we have those first questions answered, it is going to be very hard for the public agencies to mount the program if we are going to use the fishing fleet as an instrument of control this summer.

I do think, sir, we all have a lot of work to do and this very well may prove to the benefit of your group and the Governmental group if this proves to be feasible. It is certainly an avenue that we have to pursue.

MR. CHAMBERS: Right. I agree with you a hundred percent.

But here are the questions that have been asked me since these news releases came out. "Well, this is fine, the Canadians are coming in to kill off the alewife. What are you fellows going to do?" This is what has been projected to the public.

So I would like to have the public read some of this, possibly, to either counteract it or get some true basic figures out.

DR. BORUFF: Mr. Chairman.

MR. STEIN: Yes, Dr. Boruff.

DR. BORUFF: Using your terminology, while we are in this nuts and bolts consideration, we should also consider the cost of drying these fish to fish meal, which hasn't been in your discussion so far. This would also not be a small figure.

MR. STEIN: That's correct.

MR. CHAMBERS: This is a little bit out of my realm. I think Mr. Angwall is here who can probably--

MR. STEIN: Well, I think we have pursued this as far as possibly we can go now, and I do think this warrants a little technical workup so we have something really specific to deal with, and I would suggest that we might try to get the technical staffs together to work this up.'

MR. CHAMBERS: Fine.

MR. STEIN: Are there any further comments or questions?

If not, thank you very much, Mr. Chambers.

MR. CHAMBERS: Thank you.

(Applause.)

MR. STEIN: Mr. Holmer.

WINCONSIN PRESENTATION

MR. HOLMER: Mr. Chairman, fellow Conferees, ladies and gentlemen.

It is a great privilege for me to present to this audience the Governor of the State of Wisconsin, the Honorable Warren P. Knowles.

STATEMENT OF THE HONORABLE WARREN P. KNOWLES
GOVERNOR
STATE OF WISCONSIN

GOVERNOR KNOWLES: Mr. Stein, Conferees, ladies and gentlemen.

I am very pleased to have the opportunity to be here today, and I want to express my appreciation to Mr. Stein as Chairman and to the State of

GOVERNOR W. P. KNOWLES

Michigan for interrupting their presentation that I might have this occasion to present the Wisconsin story.

I am happy to really have this opportunity to join with those who share the Wisconsin interest in the future of Lake Michigan and the enhancement of America's great water resources.

It is my purpose to preface the formal introduction of Wisconsin's presentation with the firm assurance that the Badger State, to the extent of its resources, will give full and aggressive support to the Conference recommendations, which are capable of accomplishment.

Having been a member of the Wisconsin Legislature or Executive Branch of government for a period of 24 out of the last 28 years, I am fully cognizant of the history of Wisconsin's pollution problems and the programs which have been enacted into law. I myself have always been concerned as a conservationist with the matter of preservation of our water, our land, and our forests as our most precious natural resources. I, therefore, at this time would like to briefly review the history of the anti-pollution activities in the State of

Wisconsin.

During the early days of my legislative experience, from 1940 until 1948, there was very little recognition given to the problem or the effects of lake and stream pollution. In 1949, however, Wisconsin did enact the water pollution control law. This law created a committee on water pollution and appropriated funds for the study of pollution and the enforcement of abatement provisions.

During the period again from 1950 to 1965, while the water pollution committee was active, little, if any, further attention was given to legislation concerning water pollution.

In early 1961, legislation was introduced relative to detergents and also a boat toilet law was passed. The detergent bill deferred the effective date of a prohibition against non-degradable detergents until 1967. The boat toilet law was vetoed.

In 1963, another unsuccessful attempt was made at passage of legislation to restrict the use of boat toilets.

Shortly after I took office in 1965 as Governor, I created the Governor's Committee on Water

Resources, composed of both citizen and legislative members. This special committee held hearings throughout the State for an 8-month period and developed a broad and comprehensive anti-pollution control program for Wisconsin.

In June, 1966, at a resumed session of our legislature, with bipartisan support we enacted a sweeping statewide anti-pollution program that has won praise from both Secretary of the Interior Udall and from Administrator Quigley of FWPC. Secretary Udall, speaking here in Chicago, said, "It was the finest piece of legislation yet enacted in the national fight to preserve clean water." It became a model for legislation in other states.

Some of the provisions of the law are as follows:

First, it consolidated the State Water responsibilities in one department.

Secondly, it organized water management regions to utilize the technical staff in a most efficient and effective manner.

Thirdly, it provided financial assistance to accelerate construction of pollution prevention and abatement facilities. A six million dollar annual state program of grants for communities will generate $300 million of pollution abatement effort to supplement the approximately $2 million annually which has been granted by the Federal Government to Wisconsin communities. Tax incentives are also provided to encourage industrial participation in our pollution abatement efforts.

Fourth, we planned water use management and protection through the Department of Resources.

We established criteria to balance the various uses of water.

Sixth, to control pollution by identifying the sources of pollution, issuing orders to correct that pollution and implementing control through the enforcement wherever needed. And this we are doing.

We enacted in this law also a provision for shoreline and flood plain zoning. Every county in Wisconsin is required to adopt zoning ordinances to regulate the use within 1,000 feet of lakes and 300 feet from streams. Most counties have already accomplished this and others are going to complete their work during 1968. These local regulations include sanitary codes to protect all of our waters, including Lake Michigan.

The law further provided supervision and proper operation of the sewerage facilities and the installation of septic tanks by licensed sewerage plant operators and the granting of permits for septic tank installation.

The law further provided, as enacted in 1965, for a department designated as the Water Resources Center at the University of Wisconsin. It appropriated $600,000 for research at that time, which has been since supplemented and we will continue our efforts to provide for new ways of abating and preventing pollution in our lakes and streams.

And ten, it provided specifically to regulate the water quality and water structures to insure the proper development of necessary means to solve them.

Now, this legislation has been on the books in Wisconsin for two years. Our Resource Development Board and its regional counterparts are established and are already functioning effectively.

The Water Policy Board has issued more than 43 orders, and in addition more than 50 of the orders issued earlier by the Committee on Water Pollution have been referred to the Attorney General's office for prosecution.

We are very proud of our Wisconsin program. We are proud of the progress that is already being made to deal with water pollution from all sources within the State.

We are also determined--determined to proceed at full speed with the execution of the program. In December, for instance, we held hearings on pollution on the Upper Fox River and the Root River and other streams in southeastern Wisconsin. Last month we held two days of hearings on pollution on the Lower Fox River, and now we are beginning a series of separate hearings on the Milwaukee River outside of Milwaukee County.

All of these hearings are necessary as a prerequisite to new and more rigorous orders to municipalities and industries who may be contaminating or polluting these rivers. Abatement orders will be issued just as rapidly as possible and we intend to enforce these orders strictly to require compliance by both municipalities and industries wherever it is possible to do so.

GOVERNOR W. P. KNOWLES

Wisconsin, too, has welcomed the decision by Congress to require all States to adopt interstate water quality standards. Wisconsin not only moved quickly to adopt these interstate standards, but it is applying these to the inland waters as well.

Giving strength to our anti-pollution effort was the enactment last year of a sweeping reorganization of our State Government, reducing the total number of agencies from 87 to 28. The Reorganization Act brought most of our State natural resource functions together under one coordinate Department of Natural Resources. In addition, we gave the power to control air pollution and solid wastes to the newly created Department of Natural Resources.

The idea of separate agencies administering State responsibilities for fish and game and water simply would not stand. Our land resources, our fish and game, our forests, our lakes are so intertwined that they have to be managed together for proper environmental control. This was our goal. This is what we have begun to do.

In addition, we have established a Natural

Resources Council of State Agencies to work as a coordinating body to represent the natural resource interests and activities of the various agencies of State Government. I met with this group again yesterday morning. It involves all of the agencies that have anything to do with air, land, water, education, highways and agriculture, soil and water, and so forth.

And while we recognize that we do have a serious pollution problem and note the intensity of action that we are engaged in to combat pollution, it is appropriate to emphasize that Wisconsin waters have not reached a critical stage as they have in many States. Fishing is good in the great majority of our lakes and streams, and their use for recreational facilities and tourist attraction has not been diminished. Yet, we will not be satisfied until we have insured the maintenance of high water quality in all of Wisconsin's 8,500 lakes and our 20,000 miles of rivers and streams.

But, thanks to the new anti-pollution program, Wisconsin means business. We want action to clean up our waters and we're getting that action.

Business and industries, municipalities

are cooperating. The public is now concerned and, too, with the various groups of conservation, women's clubs and civic organizations throughout the State they are becoming more and more participants and involved in the problem of eradicating and eliminating contamination and pollution in the rivers and streams of our state.

I would hope that the Federal Government and Congress are equally interested in action. Unfortunately, it has been repeatedly pointed out during the course of this Conference that the Federal Government has seriously defaulted on its commitment in the battle against pollution. The Federal Government has failed to live up to either the letter or the spirit of the financial commitment under the Federal Water Pollution Control Act of 1965.

I earnestly urge the members of Congress from the four States represented at this Conference to make every effort to redeem the commitment Congress itself made to the States in the passage of the Federal Water Pollution Control Act.

The record is clear.

Congress authorized 450 million dollars for pollution control in 1968. $204 million was actually appropriated.

Second, the 1969 authorization was supposed to be $700 million, but only $225 million has been requested in the President's budget. Instead of the $1 billion $150 million promised for this two-year period, all States will now share only about $429 million or $700 million less than was promised.

And third, an Interior Department Task Force recommended immediate action to deal with the alewife problem and called for a Federal appropriation of $1.6 million for a concentrated attack on this Lake Michigan blight. Yet, the proposed 1969 budget would provide only $100,000 in new funds.

Obviously, the question confronting the President and the Congress in establishing the Federal budget is one of priorities.

We in the four States of Illinois, Indiana, Michigan and Wisconsin are acutely aware of the agony that accompanies the establishment of priorities for government spending. Our State budgets require a degree of very fine tuning far beyond the experience of the Federal Government.

In Wisconsin, for example, our current biennial budget of 1 billion 100 million dollars was financed without a tax increase for the first time in 14 years. The achievement was possible for several reasons, but among the most important was the willingness of our legislature and the Chief Executive to establish priorities of need and to invest the State resources according to those priorities.

We faced the fact that no government or no family can do all the things that it would like to do. We recognized that we had to decide, item by item, what purpose would be achieved first, second, and last.

We made our choices and the battle against air and water pollution is high on our list of priorities. As a result, our State grants and incentives to municipalities for treatment plants and tax credits to private enterprise are fully funded and the grants have been made in many instances in the early part of January of this year.

All too often, Federal officials and political spokesmen have publicly set every desirable objective as a goal. They ignore the realities of resource allocation and they have made every promise, held out every hope, and kindled every flame. In short, they have ignored priorities and responsibilities while holding out false hopes to the public. And believe me, we can no longer afford, either at the State or the Federal level, to operate on deficiency budgets to a point where we are close to bankruptcy at the national level at the present time.

As I indicated in my opening remarks, Wisconsin is prepared to cooperate fully in the support of the recommendations that are developed by this Conference. We are unequivocally committed to meet our responsibilities in the preservation of Lake Michigan. It must be recognized, however, that the Federal Government has established certain obligations beyond the financial commitments under the Federal Water Pollution Control Act.

Let me mention a few specifically:

First, the Federal Government must recognize and help the states deal with the growing threat to Lake Michigan which is created by the menace of the alewife.

GOVERNOR W. P. KNOWLES

The alewife problem demands and deserves immediate attention for several reasons:

First, tons of alewives that wash up onto Lake Michigan shores pose a serious threat to the tourist and recreation industry of the four States and are an extremely unpleasant nuisance to those who live near the lake, and certainly an economic loss to all of the States who are involved in the promotion of tourists, recreation and conservation activities.

Secondly, the Conferees here today are acutely aware of the pollution problems caused by the excessive nutrients.

Every schoolchild knows the story of the Indians who, hundreds of years ago, placed small fish beside his corn seeds as he planted them. This early method of fertilization of the soil may have been done for other reasons, but certainly its effect as far as the fertilization of the ground was a good one.

Just think of the tremendous fertilizing effect on the bottom of Lake Michigan where skin divers tell us that alewives are from three to six feet deep on the bottom at some portions of the lake. That huge amount of nutrients helps to nourish all of the undesirable growth that we're trying in other ways to reduce.

Thirdly, the publicity given to the pollution of Lake Michigan has raised the expectations of the people to the extent that they are looking for immediate and dramatic improvement in the water quality. The elimination or the drastic reduction in the number of alewives would provide tangible results that the public anticipates and expects.

Both Michigan and Wisconsin have undertaken programs of stocking Lake Michigan and Lake Superior with coho salmon. These, of course, have had a phenomenal growth with their voracious and enormous appetites for alewife. At the same time, the coho is generating a new enthusiasm among sports fishermen and have the potential for boosting the tourist industry along the shores of the Great Lakes.

If the Federal Government were to marshal its anti-pollution forces in the battle against the alewives, we could make significant gains within a short period of time and demonstrate our determination to fight pollution in Lake Michigan.

Other specific obligations, I think, include:

First, the establishment of a feasible and aggressive timetable for abatement of industrial and municipal pollution around the lake.

Second, guideslines must be established to eliminate the dumping of waste and sewage by boats into the Great Lakes.

Third, dredging and the deposit of polluted waste by the Corps of Engineers must be controlled while, at the same time, maintaining adequate channels for commercial shipping.

I recognize, as everyone at this Conference, that these problems are very difficult and very complex. But like those challenges we face within each state, they must be dealt with and overcome.

I have often said that we do not have a magic wand, those of us who are in legislative or executive positions. There is not at the present time a miracle pill that would dispose of pollution wastes in one fell swoop. It is going to take money, patience, understanding, and public support. The problem is smelly and slimy and green, and there is only one way we are going to really cope with this problem and that is through the utilization of our best efforts and talents and greenbacks as a means of solving the problem.

I want this Conference to know that under my administration, and with the cooperative efforts of the Legislature, the State agencies and our people, Wisconsin stands ready to do its part in the fight against water pollution within our State as well as in our border waters.

If the Federal Government will actively fulfill its role, the role that it has created for itself, I think we can make even more progress. We are certainly willing to recognize and to cooperate with the Federal Government on a partnership basis in treating these problems.

And so I urge the members of Congress to review the water pollution problems in the terms of the Nation's priorities of need. If they determine that anti-pollution efforts are truly a priority item, I hope they will secure adequate Federal financing for the program. If the problems related to water pollution are not so urgent as to take the priority over all other national needs, then let them tell us so, let them tell the American people, so that the public will no longer anticipate the fast Federal action that has been so long promised.

Our challenge is to reverse the trend of more than 50 years of contamination, pollution, eutrophication and netting in our lakes, streams and rivers. I am here prepared to say to all of you that Wisconsin is ready, willing and able to do its part.

Thank you.

(Applause.)

MR. STEIN: Thank you very much for a very complete and inspiring speech, Governor. I am sure it sets a pattern and a blueprint for the State-Federal Cooperative Program.

We will now return to the Michigan presentation.

Mr. Vogt.

MICHIGAN PRESENTATION (CONTINUED)

MR. VOGT: Mr. Chairman, I have several

letters and communications which I would like at this time to introduce into the record, and they are being distributed now. We will not read them, but I would like to just read the name of the person who wrote the letter and the city or the organization which he represents.

The first letter is from Mr. H. Wybenga, the City Superintendent of the City of Zeeland, Michigan.

The second letter is from the City of Charlevoix, dated January 15, and is signed by Mr. James Taylor, City Superintendent.

The third letter is dated January 4th from a firm of attorneys at Bridgman, Michigan. The firm name is Lagoni & Davis, and the letter is signed by Mr. William O. Lagoni, Chairman, Park Committee, City of Bridgman.

The next communication is dated January 12th from the Parke-Davis Company at Detroit, and it is signed by Mr. Charles H. Kupsky, General Manager.

The next communication is from the Martin Marietta Corporation, and it is from Mr. Roy Calvin, the Director of Public Relations for the Corporation.

Next is a statement prepared by Mr. John Kinney and Mr. Charles B. Wurtz, Consulting Engineer and Consulting Biologist, respectively, for the Dunbar & Sullivan Dredging Company, and this is dated the 22nd of January, 1968.

The next communication with attachments is from the Joseph B. Stinson Company, dated January 31st, signed by Joseph B. Stinson.

The next is a communication from the Michigan Society of Professional Engineers, dated January 22nd, signed by Clair Aiken, Vice President of the Society.

The next statement is from the Michigan Society of Planning Officials, dated January 16, signed by Mr. Bruce C. Brown, Executive Secretary.

The next is a statement by the Michigan Pesticide Council, dated January 31, and it is signed by Mr. Norman Spring, Chairman, Michigan Pesticide Council, Grand Haven.

The next statement is from the Michiana Watershed, Inc., at Niles, dated January 26, 1968, signed by Mr. S. R. Dunnuck, Jr., Secretary of the Berrien County Chapter.

Mr. Chairman, these communications were

all addressed to Mr. L. F. Oeming, the Executive Secretary of the Michigan Water Resources Commission as a result of the notification by him to these people inviting statements either orally or written. These written statements I would like to have introduced into the record.

MR. STEIN: Without objection, they will appear in the record as if read.

(Which said statements are as follows:)

CITY OF ZEELAND
ZEELAND'S "1970" PLAN
Building for the Future

21 South Elm Street - Zeeland, Michigan

January 8, 1969

Michigan Water Resources Commission
200 Mill Street
Lansing, Michigan 48926

Attention: Mr. Loring F. Oeming, Executive Secretary

Dear Sir:

In answer to your letter dated December 29, 1967, and the instructions I received from the City Council at their January 2, 1968 meeting, I would like to make the following statement on the city's behalf:

The activated sludge plant which treats

the city's waste materials was expanded two years ago. At present we are at 50% plant capacity with the B.O.D. and suspended solids removal at 90% or above. Our average B.O.D. in milligrams per liter is 14 with the suspended solids at 28 milligrams per liter. This would place in the north branch of the Black River a 30 pound average of B.O.D. waste and a 83 pound average waste of suspended solids per day. Our average flow is just under one-half million gallons per 24 hours. Therefore, I am sure that the city does not contribute to the pollution of Lake Michigan which is twelve miles from the city. I understand that the change of water in Lake Macatawa is about a two year cycle.

The City of Zeeland is interested in the watershed and would do everything in its power to retain or restore the lake to its original condition.

Respectfully yours,
CITY OF ZEELAND, MICHIGAN
(Signed) Herb Wybenga
H. Wybenga, City Superintendent

HW/nt
cc: Mr. Donald Pierce, Michigan State Health Dept.
Mr. Carl Danielson, Zeeland Councilman
Mr. Leon Van Harn, Zeeland City Clerk
Mr. Tom Hoogerhyde, Mich. State Health Dept.

CITY OF CHARLEVOIX

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CITY OF CHARLEVOIX
OFFICE OF CITY SUPERINTENDENT
CHARLEVOIX, MICHIGAN

January 15, 1968

Mr. Loring F. Oeming
Executive Secretary
Water Resources Commission
200 Mill Street
Lansing, Michigan 48926

Dear Sir:

Subject: Federal Conference on Pollution of Lake Michigan and its Tributary Basin

We are a Recreational community with a winter population of 3000 and a summer population of 7000, located on the northerly part of Lake Michigan. In fact, we are real water-minded, as Lake Michigan is our west city boundary, connected by a channel to 60-acre Round Lake, that forms the center of the community. It is, in turn, connected by a channel to Lake Charlevoix, which is the third largest lake in Michigan. This receives the flow from the drainage basin of two small rivers; namely the Boyne River and the Jordan River.

CITY OF CHARLEVOIX

Located as we are, we see many places where raw sewage is allowed to flow into the rivers and lakes from industries, clubs, and residences, plus the bilge water from many boats. In view of this, we strongly recommend more stringent laws and closer policing to correct this problem.

Respectfully submitted,
CITY OF CHARLEVOIX
(Signed) James Taylor
James Taylor
City Superintendent

JT/bg

- - -

LAGONI & DAVIS

Attorneys at Law

310 Red Arrow Highway
Bridgman, Michigan 49106

Wm. O. Lagoni
John E. Davis

Telephone
HOpkins 5-1111

January 4, 1968

Mr. Loring F. Oeming
Executive Secretary
Department of Conservation
200 Mill Street
Lansing, Michigan

Dear Mr. Oeming: Re: Federal Conference on Pollution of Lake Michigan and its Tributary Basin

CITY OF BRIDGMAN

At the request of the Mayor and the City Council for the City of Bridgman, Michigan, I am responding to your letter and invitation dated December 29, 1967.

The City of Bridgman has a thirty acre park located on the shores of Lake Michigan. Both the residents of the City of Bridgman and Lake Township use the beach extensively, as do others from all over the United States.

The City is very concerned that unless some action is taken immediately to control the pollution of Lake Michigan one of our greatest natural resources will be lost to the public. I am sure you are aware of the alewives problem, and the money loss of revenue due to the campers and swimmers who stayed away from the Lake. Not only have we had a serious loss of revenue, but have had to expend considerable funds to clean the beach.

There is no question in our mind that Lake Michigan is being polluted. You have only to walk the beaches and look at the water to determine this. We have been unable to obtain any assistance in the abatement of any pollution in our area, except by our own efforts through the City. The City

CITY OF BRIDGMAN

has spent a considerable amount of money cleaning up the beaches in the City. Unless some immediate action is taken by the Federal and State government to assist the local communities the pollution of Lake Michigan will occur faster than the local efforts can be taken to control it.

It is our hope that immediate action will be taken to control the pollution of Lake Michigan. You may be assured of our enthusiastic support of any measures taken to abate the pollution.

Sincerely,
(Signed) William O. Lagoni
William O. Lagoni, Chairman,
Park Committee, City of
Bridgman

WOL:jmh

CC: Clerk, City Commission

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PARKE-DAVIS & COMPANY

Detroit, Michigan 48232 U.S.A.
Holland, Michigan
188 Howard Avenue

January 12, 1968

Mr. Loring F. Oeming
Executive Secretary
Water Resources Commission
200 Mill Street
Lansing, Michigan 48926

PARKE-DAVIS & COMPANY

Dear Mr. Oeming:

I would like to thank you for your letter of invitation to the Federal Conference on pollution of Lake Michigan and its tributary basin scheduled for January 31, 1968.

It will be impossible for me to attend this session; however, we, as a company, are extremely interested in obtaining a transcript of the information gathered at this meeting. We feel this approach of having industry and state governments assemble to discuss problems that are of mutual concern is extremely necessary and essential in order that we better understand each others problems and concerns.

I would like to thank you again for the invitation and would hope that it would be possible for you to transmit any information obtained at this meeting to us.

Respectfully yours,
(Signed) Charles H. Kupsky
Charles H. Kupsky
General Manager

jw

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MARTIN MARIETTA CORPORATION

Lake Michigan Pollution

Martin Marietta Corporation's policy incorporates the basic concept that the environment adjoining its facilities will be protected from pollution. Continuing recognition is being given to governmental policies and satisfaction of legal requirements as they concern land reclamation, control of atmospheric and water pollution.

In new construction or the modernization of company installations, the Corporation requires that all relevant regulations pertaining to air and water pollution are met.

In the interest of hastening an overall solution, it is suggested that any legislation considered for pollution abatement should include incentives that might encourage the entire industrial community, rather than relying on solely punitive legislation. The company encourages full participation of our staff in seeking solution of pollution problems and feels that Government-industry teamwork is the best avenue for meaningful progress.

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ENVIRONMENTAL CONSIDERATIONS OF DREDGING, POLLUTION, AND THE GREAT LAKES

(Progress Report No. 1)

Prepared by

John E. Kinney
Consulting Engineer
1910 Cambridge Road
Ann Arbor, Michigan 48104

and

Charles B. Wurtz
Consulting Biologist
LaSalle College
Philadelphia, Pennsylvania 19141

for

Dunbar & Sullivan Dredging Co.

22 January 1968

As a result of the Federal water pollution control conference agreement of December 21, 1965, against the disposal of "deleterious waste solids" into Lake Michigan, representatives of dredging companies met with Frank DiLuzio, then Assistant Secretary of Interior in charge of water pollution, in Washington, D.C. In Mr. DiLuzio's stated opinion such a prohibition without determining alternatives and without a determination of the evidence that such disposal was in fact causing pollution was premature. He reported that the Corps of Engineers and the Federal Water Pollution Control Administration (FWPCA) were arranging a joint study of various methods of handling dredged material and that until the study was completed, dredging and disposal would continue as in the past.

The Congress subsequently funded such a joint study ($1 million) and later extended it by a second appropriation (for a total of $6 million) for the second year of research and analysis. Two years was the original estimate of time required, but it now appears this was too optimistic a forecast.

Because of the vital significance of the decisions on the dredging industry, representatives of that industry decided to undertake a separate and independent study. The industry felt that if there are adverse effects from disposing of dredged material in the lakes, a solution might include changes in practice of haulage and/or dumping. As the contractors in the activity their knowledge of practicalities would be of value. The dredging industry representatives volunteered this assistance to Mr. DiLuzio when he described the advisory committee being assembled to coordinate and evaluate the study. He agreed industry representation on the committee could be helpful but an invitation was never extended.

One other factor motivated the dredging industry's independent study. Permits to dispose of dredged material in Lake Erie were refused by the Corps on the basis of a letter memorandum from the FWPCA. This letter offered the opinion that the material to be dredged "could" cause pollution since it contained organic matter. Whether it would cause pollution and to what extent were not defined. The dredging representatives felt that a better guideline was required.

In order to develop data from which sound conclusions could be drawn Dunbar and Sullivan Dredging Company retained two consultants, an aquatic biologist and a sanitary engineer, to outline surveys in Lake Erie and Lake Michigan. The analytical work was to be done by independent laboratories, the Detroit Testing Laboratory, Inc., and the Pollution Control Laboratories, Inc., in Chicago. Appraisal of data and conclusions are the responsibility of the consultants.

The surveys were designed to define:

1. Whether the sampling procedure employed by the FWPCA at the site where dredging is to be done accurately measures the polluting potential of the material to be dredged.

2. Whether the water quality over the authorized dumping sites varies from lake quality at remote sites.

3. Whether the water quality at the disposal site varies at time of dumping, and if so, for what period of time.

4. Whether there is an influence on water quality from disposal of dredged material which extends beyond the disposal area.

5. Whether there is a detrimental

physical or biological effect on the lake bottom due to the dredged material.

6. Whether there is a detrimental physical, biological or chemical effect on the water quality in the lake due to the disposal of dredged material.

Such answers are required to determine whether lake disposal of dredged material should cease. The importance of such a decision is emphasized by consideration of the alternatives for disposing of such material, either on shore or within diked areas. Such approaches:

-- require specialized equipment and make bottom dump scows obsolete. The economic impact on dredging companies and on the Corps of Engineers is highly significant.

-- increase the cost of disposal some three hundred per cent (300%). With 108 harbors on the Great Lakes the increased cost would be so great as to cause a large reduction in the number of harbors maintained for navigation. This will directly depress the local economy of each city so affected.

-- fill in marsh land and this in turn adversely affects the ecology of the lakes. On-shore disposal would necessarily utilize cheaper land and this would be the marshy bottoms so important as water fowl habitat and sources of biological nutrients. In addition, these marsh lands act as a sponge which controls the balance of a lake water level and the inland water table through its hydrostatic head. The effects of filling the marsh lands along the east coast is now apparent in the salt water intrusion.

-- permit seepage over long periods of time of the organic and mineral nutrients which may be in the dredged material. This occurs because rainwater falls on such sites and leaches the salts from the fill. This does not occur when the material is compacted in the bottom of a lake, especially if covered by the siltation resulting from bottom currents. Thus, with the constant leaching from

> shore or dike disposal the overall contribution of nutrient to the lake would undoubtedly be greater. If the material is deposited directly into the lake the potential contaminants remain contained and do not enter into chemical or biological recycling.
>
> -- are obviously limited by land availability. Since land wash, street wash, reservoir drawdown and residual discharges from treatment plants contain organics, there will always be material other than silt or sand in dredgings. Hence this problem of disposal requires a longer term solution than permitted by land availability.

TEST SITE LOCATIONS

The two studies were in Lake Michigan and Lake Erie.

The Lake Michigan disposal area is in Indiana waters at the site authorized by the Corps of Engineers. Dredged material came from the Indiana Harbor Ship Canal.

The disposal site is located 1.5 miles northeast of the FIW Gong -- about 8 miles from shore and about 12 miles from the City of Chicago intake. Depth of water at the site is approximately 55 feet.

Sampling stations were arranged on a grid with distances from 0.5 miles to 7.0 miles. The latter was eastward of the disposal site and considered to be the control point as representative of lake water quality. It is 14 miles from the entrance of the Indiana Harbor Ship Canal. Depth of lake at that point is 72 feet.

The Lake Erie site is downstream from the Detroit River Light and west of the west outer channel between Bouy No. 5 and Bouy No. 7. The authorized disposal site extends for 9000 feet adjacent to the west outer channel and for a distance of 5000 feet to the west. The site is about 2 miles from the Michigan shore. Sampling stations were on a grid and varied from 1000 feet from the disposal point to the extreme corners of the overall area. The lake depth in this area -- 15 to 18 feet.

The water quality analyses done on

samples drawn from the Indiana dumping grounds in Lake Michigan include water quality measurements at depths of five feet, thirty feet, and one foot from the bottom. A series of 27 samples was taken July 28, 1967, when no dumping was being done. A second series, of 33 samples, was taken October 15, 1967, at 15 to 20 hours after a dump of 91,000 cubic yards of material dredged from Indiana Harbor. Since the material dredged is primarily solid, the most direct assessment of dump effects on lake water would be the measurement of total solids present in the water. These data, among others, were collected by Pollution Control Laboratories, Inc. Some analyses of the data follow:

Total Solids in Water of Indiana Dumping Grounds

	July 28, 1967		
Depth	5 ft.	30 ft.	Bottom
Range of Values or mg/l	166-207	152-201	152-207
Standard Deviation (s)	14	14	19
Variance (S^2)	216	202	369
Coefficient of Variation (V)	7.7%	8.0%	10.7%

J. E. KINNEY AND C. B. WURTZ

Total solids in Water of Indiana Dumping Grounds

	October 15, 1967		
Depth	5 ft.	30 ft.	Bottom
Range of Values or mg/l	139-192	137-204	140-176
Standard Deviation (s)	18	19	11
Variance (S^2)	327	346	131
Coefficient of Variation (V)	10.8%	11.4%	6.9%

It is apparent from the preceding data that the lake water in the dumping ground is fairly uniform with very little variation about the mean at each stratum.

Although the various water strata appeared to deviate little from each other, a further analysis was done to determine whether or not there was a correlation between dumping and total solids present. Spearman's rank order correlation coefficient was developed for this determination.

With one exception none of the derived coefficients showed any correlation. The exception is the comparison between the five-and-thirty-foot depths (T=0.855) on October 15th. A correlation in these upper water strata is not surprising within 24 hours of a dump. What is surprising is the lack of correlation between 30 feet and the bottom (T=0.391). It is obvious that some pronounced horizontal shear effect was dispersing the suspended solids in the deeper water on that day. With the limited data to date no suggestion as to the nature of this phenomenon can be offered except that it probably relates to the internal hydraulics of the lake

The conclusions drawn from evalution of data on solids are supported by other analytical data. However, the concentrations reported for BOD, oil and grease, suspended solids, turbidity and bacteria were so low, similar appraisal is not feasible.

The range of data from all stations, including the station at the point of dumping, demonstrates that the resultant water quality after dumping is not significantly different from the quality before dumping and definitely not of impaired quality.

July 28

Before Dumping

	Dump Site	7 Area Stations	Control Stations
PH	8.0-8.3	8.0-8.3	8.1-8.3
BOD ppm	<5	<5	<5
Oil and grease ppm	<1	<1	<1
Suspended solids ppm	0	0	0
Coliforms (confirmed)/100 ml.	0	0	0
Fecal Enterococci	0	0	0
Turbidity JTU	2-9	0-10	4-6

October 15

After Dumping

	Dump Site	7 Area Stations	Control Station
PH	8.2	8.2-8.3	8.3
BOD ppm	5	5	5
Oil and grease ppm	1	1	1
Suspended solids ppm	0	0	0
Coliforms (Confirmed)/100 ml.	8-94	4-172	14-130
Fecal Enterococci	0	0	0
Turbidity JTU	0-5	0-10	2-9

The data show no difference between the two dates for oil, suspended solids and turbidity which confirms the conclusion drawn for solids.

Also there was no significant difference in PH or BOD measurements.

The data on bacterial counts show an increase in coliforms for the day sampled after dumping, but with no measurable fecal streptococci. However, it should be noted that the coliforms were relatively low (less than 200) and that the control station seven miles to the east had concentrations in the same order of magnitude. The highest values were surface samples with analyses at lower depths showing lesser concentrations. For example, the surface sample at the dump site had a coliform count of 94 but at 5 feet the count was 33, at 30 foot depth the count was 21, and one foot from the bottom the count was 8. In similar manner at the corresponding depths at the control station the counts were 130 (surface), 33 (5 ft.), 21 (30 ft.) and 14 (bottom). This indicates not only that the higher counts were prevalent in the lake but were wind influenced.

J. E. KINNEY AND C. B. WURTZ

Analysis of Material Dredged

There are two questions with respect to material to be dredged:

-- does the Petersen dredge, which actually measures only a surface layer of the material, provide a representative sample of the material to be dredged?

-- does the analysis of the material dredged provide a true indication of the effect of lake disposal of the material?

Considering the second question first, the issue resolves itself into determination of whether any material should be disposed of into the lake if it is "polluted" by any proposed yardstick or whether any material can be disposed of in the lake if it does not cause pollution?

There is a big difference. According to Federal law (Section 10(c)(5) "the discharge of matter into such interstate waters or portions thereof; which reduces the quality of such waters below the water quality standards . . . . is subject to abatement." Clearly the test is whether it adversely affects water quality rather than whether it may be classified as polluted per se.

It is important to note that the conference recommendation did not propose exclusion of dredged material but rather "deleterious waste solids and other such material". To be deleterious it must have an adverse effect. Simply calling material "polluted" does not demonstrate effect.

Analysis of the scow material as it left Indiana Harbor Ship Canal showed a BOD of 167 mg/gr, a coliform MPN of 1100 per gr and fecal enterococci counts of 0 to 4000 per gr. This could be classified as polluted in terms of bacterial content but it caused no measurable effect on the lake quality.

The bottom sample studies completed to date have been chiefly on materials intended for disposal in the Lake Erie dumping ground. These analyses were performed by the Detroit Testing Laboratory. Of particular interest in this work is the difference in results obtained by the use of different samples. One sampler, the Petersen grab sampler, is a small clam bucket that samples bottom materials to a maximum depth of about four inches. (This type sampler has been used by the FWPCA.) A second sampler was a tube sampler that took a core of bottom material to a depth of three feet. The second sampler gathers material from depths below the zone of recent deposition in which contaminants are actively reacting with overlying waters.

Four sites within the Old Rouge-Detroit River system were sampled. These were all taken from undisturbed bottoms and included: (1) A site in the Detroit River above the confluence with the Old Rouge River, (2) A site in the mouth of the Old Rouge River, (3) A site in a slip off the Detroit River below the outfall of the Detroit sewage effluent, and, (4) A site in the Detroit River downstream from Site 3.

The Biochemical Oxygen Demand (BOD) test was one of several analyses done on this bottom material. (Other analytical results have not yet been critically reviewed.) The BOD data, expressed as ppm, are tabulated below.

Site	Petersen Sample	Tube Sample
1	93.2	16.4
2	12.8	15.1
3	123.2	31.5
4	62.6	18.6

At Sites 1, 3 and 4 the Petersen samples showed significantly higher BOD values than did the tube samples. No significant difference was found at Site 2, where the values were practically the same. These data clearly demonstrate the inadequacy of the Petersen grab sampler as a device for measuring potential pollutional loadings from bottom materials to be removed by dredging. In this instance, for example, the sampling technique showed four-fold increase over actual BOD loads present.

SUMMARY

An appraisal of the problem of disposal of dredged material points up the fact that a simple prohibition on the disposal of such material into lakes does not solve the problem. In fact, alternately proposed solutions such as on-shore or within diked area disposal will create even greater adverse effects on the ecology of the lake over a long period of time.

The study which is supposed to be underway in Lake Michigan by the Corps of Engineers and the Federal Water Pollution Control Administration jointly should be completed before rash decisions are made.

The data from surveys in Lakes Erie and Michigan financed by the dredging industry demonstrates very clearly:

-- that the sampling procedure employed by the FWPCA does not measure the polluting potential of material to be dredged.

-- the water quality over the authorized disposal sites indicates lake water quality is not adversely affected by the dumping.

-- there is an indication of quality change at the dumping site but it is very transient (of short duration) and of less than 24 hours.

The evaluation of all the data from these study is not completed. These data plus those which should be made available from the Federal study will adequately answer the question as to whether there are any physical, biological or chemical adverse effects on lake water quality or bottom materials.

However, until there are data which indicate these conclusions are in error, it is our opinion that the continuance of disposal of dredged material in Lake Michigan is not detrimental and is in the public interest.

- - -

THE JOSEPH B. STINSON CO.

Designers and Builders of Automation Equipment
Area Code 419-332-8286
406 Justice St., Fremont, Ohio, 43420

January 31, 1968

Gentlemen:

Several weeks ago I met with a group of boating officials and members of the press at a local yacht club. It was decided at that meeting a resolution would be presented at this conference.

I endeavored to impress upon these people the injustice they would be doing to the boaters if they were to settle for a partial pollution control system.

I also noted at the meeting the Federal Water Pollution Control Administration report August 7, 1967, indicated a total of 25 states and the Province of Ontario approve holding tanks, or no discharge of sewage. Therefore, a holding tank would be the best consideration because there would be no limitations on your voyaging. With this in mind it would be even more ridiculous to settle for a partial treatment unit, which is subject to human tampering, human failure, and mechanical failure; especially since more than 35 states now do not approve of the disinfectant devices. Chlorine can be dangerous if not properly handled or stored. Last Friday 15 persons in Fort Bragg, North Carolina, were overcome by leaking chlorine gas. I also call your attention to Hawaii, with all its surrounding water, calls for sewage control and has approved the holding tank.

We now have a design criteria from both the American Boat and Yacht Council and The National

Sanitation Foundation for holding tanks and standards for shore connections.

In my opinion no self-respecting boatman wants to add to the pollution problem, no matter how infinitesimal. However, we must be assured the lawmakers are equally as zealous in cleaning up the major sources. How can we, as boaters, ask others to stop polluting the waters if we are willing to settle for partial measures, or perhaps try to get out of it altogether.

The production of the coin—operated dock mounted discharge pumps will give 24-hour availibility for discharging. This leaves no reasonable excuse to consider questionable quality of sewage discharge into the water.

In conclusion, I have attached copies of letters from water control boards from various states, presently without water pollution laws, stating their opinions and other pertinant information for your contemplation.

Respectfully submitted,
(Signed) Joseph B. Stinson

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BOATING REGULATIONS IN THE NATIONAL PARK SYSTEM*

AUGUST 1964

NATIONAL PARKS AND MONUMENTS

Water Sanitation - (1) No fish, offal, bottles, cans, rubbish or other refuse shall be discarded or otherwise disposed in the waters.

(2) All vessels operating on the waters shall have a waste receptacle aboard in which all rubbish and refuse shall be deposited. Receptacles shall only be emptied in facilities provided at docks or other specified places.

(3) No person shall discharge or otherwise permit the disposal of toilet wastes into the waters within one-half mile from the nearest shore, unless such wastes are adequately treated by an effective sewage disposal system, including chemical or heat process, which results in disposal of liquid and solid wastes without pollution of the waters: except, that no wastes of any kind may be disposed in the waters within one-half mile of any water supply intake.

Inspections - The Superintendent or his

authorized representative may at any time board any vessel while afloat or underway to examine documents, licenses, and/or permits relating to operation of the vessel and to inspect such vessel to determine compliance with regulations.

NATIONAL RECREATION AREAS

Water Sanitation - (1) No fish, offal, bottles, cans, rubbish or other refuse shall be discarded or otherwise disposed in the waters.

(2) All vessels operating on the waters shall have a waste receptacle aboard in which all rubbish and refuse shall be deposited. Receptacles shall only be emptied in facilities provided at docks or other specified places.

(3) No person shall discharge or otherwise permit the disposal of toilet wastes into the waters within one mile from the nearest shore, unless such wastes are adequately treated by an effective sewage disposal system, including chemical or heat process, which results in disposal of liquid and solid wastes without pollution of the waters: except, that no wastes of any kind may be disposed in the waters within one mile of any

water supply intake or within Shadow Mountain National Recreation Area.

Inspections - The Superintendent or his authorized representative may at any time board any vessel while afloat or underway to examine documents, licenses, and/or permits relating to operation of the vessel and to inspect such vessel to determine compliance with regulations.

*Excerpts from National Park Service Publication (F.R.Doc. 64-6745)

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ORSANCO ACTS TO CONTROL BOAT WASTES

The Ohio River Valley Water Sanitation Commission (ORSANCO) recently passed a resolution aimed at controlling the discharge of wastes from boats and floating facilities in its jurisdictional area. The increased popularity of boats and rising river water quality have demanded this action. The resolution reads as follows:

"WHEREAS: The discharge of untreated wastes from commercial and pleasure watercraft and floating facilities operating within the

Compact District may cause pollution contrary to the language and intent of the Ohio River Valley Water Sanitation Compact: and

"WHEREAS: Substantial progress has been made in eliminating discharges of untreated wastes from municipalities, industries, and other onshore installations in the District:

"NOW THEREFORE: For purpose of safeguarding the waters of the District as specified in Article I of the Compact:

"BE IT RESOLVED: That the following measures are hereby adopted by the Commission to be followed by the signatory states for the joint cooperative control of waste discharges from watercraft and floating facilities, such measures to become effective January 1, 1967:

"1. No marine waste-disposal system on any watercraft or floating facility operated on waters within the District shall be so constructed and operated as to discharge inadequately treated wastes into these waters.

"2. All marine waste-disposal systems shall be sealed or otherwise rendered inoperative on waters where use of such systems is prohibited federal, state or local regulations.

"3. On waters within the Compact District where the operation of marine waste-disposal systems is permitted, such systems on or within any watercraft or floating facility shall include a suitable operating treatment device for the maceration and disinfection of wastes prior to discharge. In lieu of treatment, wastes from watercraft and floating facilities shall be collected in holding tanks properly equipped so that the wastes can be discharged to approved shore-based installations.

"BE IT FURTHER RESOLVED: That the Commission request that each of the signatory states take steps to carry out the provisions of this resolution; and

"BE IT FURTHER RESOLVED: That the Commission direct the Engineering Committee to provide a guideline memorandum for use in implementing this resolution; and

"BE IT FURTHER RESOLVED: That, following the effective date on this resolution, the U.S. Coast Guard and appropriate signatory state enforcement agencies, in connection with their routine licensing inspections of watercraft and floating facilities operating within waters of the Compact District, be requested to report to the appropriate state agency or to the Commission those watercraft and floating facilities not complying with this control measure."

HIGHLIGHTS, WATER POLLUTION CONTROL FEDERATION, May 1965

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RULES AND
REGULATIONS
COVERING
DISPOSAL OF
WASTES FROM
WATERCRAFT

.Adopted by the
Texas State Board of Health
June 13, 1966.

TEXAS STATE DEPARTMENT OF HEALTH

RULES AND REGULATIONS COVERING DISPOSAL OF WASTES FROM WATERCRAFT

1.0 PURPOSE

To prescribe methods and procedures for the construction and operation of marine toilet devices for use on watercraft. Such rules and regulations are considered necessary to assure that the water resources of this State can be developed to provide maximum benefits, i.e., water supply, recreation and other beneficial uses influenced by quality conditions.

2.0 AUTHORITY FOR RULES AND REGULATIONS

2.1 The State Department of Health was established by Article 4414a, Title 71, 1925, Revised Civil Statutes of Texas, to better protect and promote the health of the people of Texas.

2.2 Article 4419, Title 71, 1925, Revised Civil Statutes of Texas, states that "The State Board of

Health shall have general supervision and control of all matters pertaining to the health of citizens of this State." By virtue of Article 4418d, Title 71, 1925, Revised Civil Statutes of Texas, the Commissioner of Health has the power, with the approval of the State Board of Health, "to prescribe and promulgate such administrative rules and regulations not inconsistent with any law of the State as may be deemed necessary for the effective performance of the duties imposed upon the State Department of Health and its several Officers and Divisions."

2.3 Article 4477-1, Vernon's Texas Civil Statutes, Section 20.(b), "The Texas State Department of Health shall take all necessary procedures essential to the protection of any spring, well, pond, lake, reservoir, or other streams in Texas, from any condition or pollution resulting from sewage that may endanger the public health, and shall have full authority to enforce all the laws of this State relating thereto."

2.4 These Rules and Regulations shall constitute the policy of the State Board of Health and shall be enforced by the appropriate Local Health Officer as set forth in Articles 4427 and 4430, Vernon's Statutes of Texas.

3.0 DEFINITIONS

3.1 These rules and regulations for marine toilets have been adopted by tha Texas State Board of Health. The following definitions shall apply in the interpretation and enforcement of these regulations.

3.2 Boat means any vessel or other watercraft, whether moved by oars, paddles, sails, or other power mechanism, inboard or outboard, or any other vessel or structure floating upon the waters of this State, whether or not capable of self-locomotion, including but not limited to cabin cruisers, house-boats, barges, marinas and similar floating objects.

3.3 Marine Toilet means any toilet on Or within any boat.

3.4 Other Disposal Unit means any device on or within any boat, other than a marine toilet, which is intended for use in the disposal of human body wastes.

3.5 Sewage means all human body waste.

3.6 Holding Tank - a tank to be used for receiving and retaining sewage.

3.7 Waters of the State means all streams, lakes, reservoirs, water courses and all other bodies or accumulations of water, natural or artificial, which are contained within or flow along the border of or through the territorial jurisdiction of the State.

3.8 Septic Action - Sewage undergoing putrefaction under anerobic conditions.

4.0 SEWAGE DISPOSAL DEVICES AND EQUIPMENT

4.1 Any marine toilet located on or within any boat operated on waters of this State shall have securely affixed to the discharge outlet a holding tank located on the boat, provided so as to meet the following specifications:

4.1.1 The holding tank shall be so constructed as to prevent the removal of the sewage held therein except by pumping therefrom by onshore facilities.

4.1.2 The holding tank shall be constructed of material which will withstand the corrosion effects of the sewage and the disinfecting chemicals used. It shall be so located as to minimize the possibility of rupture.

4.1.3 The holding tank shall be properly vented to the outside of the boat in such a manner as not to defile the interior of the boat structure.

4.1.4 The contents of holding tanks shall be discharged only to onshore facilities constructed, operated, and maintained so as to prevent possible entrance of waste materials into the waters of the State.

4.2 Contents of other disposal units shall be disposed onshore in such a manner as not to create a public health nuisance and to prevent possible entrance into the waters of the State.

4.3 Refuse, including garbage, rubbish, and litter, shall be deposited onshore in approved type receptacles, which are maintained properly, with ultimate disposal in such a manner as to prevent the creation of a public health nuisance as well as prevent possible entrance into the waters of the State.

5.0 MINIMUM STANDARDS

5.1 Compliance with these rules and regulations will be considered as meeting minimum standards.

5.2 Other devices for the control of wastes from watercraft may be considered as acceptable provided that the local health authority assures the State Department of Health in writing that such devices are being inspected and maintained in such a manner as not to constitute a hazard to health.

5.3 These rules and regulations are not designed to supersede more restrictive rules and regulations or ordinances adopted by local political subdivisions of the State for the regulation of marine toilets and waste from watercraft in their area of jurisdiction.

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ONTARIO WATER RESOURCES COMMISSION
801 Bay Street
Toronto
A. VANCE, LL.D. Telephone 365-1491 D. S. CAVERLY
Chairman General Manager
H.H. ROOT, M.P.P. W. S. MacDONNELL
Vice-Chairman

November 27, 1967

AIRMAIL

Mr. Joseph B. Stinson,
President
The Joseph B. Stinson Company Limited,
406 Justice Street
FREEMONT, Ohio 43420,
U. S. A.

Dear Mr. Stinson:

Re: Ontario Regulation 365/66

Thank you for your telephone call today to our Mr. Murphy.

The above Regulation becomes effective June 1, 1968. As of that date, all pleasure craft in the Province of Ontario will be required to have a device to hold sewage aboard for subsequent disposal ashore, or a macerator chlorinator which may be used with a temporary OWRC permit until June 1, 1971.

While there is no doubt that this law will be enforced, we are looking to the Minister's Office for a public statement to this effect to quell any rumours that the law will be changed.

Enclosed are two copies of application form No. 1 which you should use to apply for acceptance of your holding tanks. If you will be kind enough to complete the applicable sections of the form and send one copy to us, it will receive our prompt attention. We will also appreciate receiving a brief description of the dockside sewage pump which you propose to market in Ontario.

I trust that this is satisfactory.

Yours very truly,
(Signed) P. G. Spenst
P. G. Spenst, Supervisor,
Plumbing and Boating Branch,
Division of Sanitary Engineering

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ONTARIO WATER RESOURCES COMMISSION

Toronto

December 5, 1967

The Joseph B. Stinson Company,
406 Justice Street,
FREEMONT, Ohio 43420,
U. S. A.

ATTENTION: Mr. Joseph B. Stinson
President

J. B. STINSON

Gentlemen:

Re: Acceptance of Jonny Trap Holding Tank

The Jonny Trap holding tank system as described in your application on Form No. 1 dated November 30, 1967 is accepted for use on pleasure boats in the waters of the Province of Ontario. This acceptance relates only to its use as a device for the storage of human excrement for subsequent disposal ashore in compliance with Ontario Regulation 365/66 and does not constitute an endorsement for the durability of its components, the operation of its associated parts or its suitability for any other purpose.

This acceptance is contingent upon this system's being installed and arranged so that sewage consisting of human excrement deposited into it or into any toilet connected to it is prevented from entering any water.

This acceptance is given on the understanding that persons owning boats on which this system is installed are required to obtain OWRC approvals to operate the devices on their boats.

Yours very truly,
(Signed) T. M. Murphy,
T. M. Murphy, Technician,
Plumbing and Boating Branch.

APPLICATION FOR APPROVAL OF DEVICES FOR THE TREATMENT, STORAGE, OR DISPOSAL OF SEWAGE CONSISTING OF HUMAN EXCREMENT IN A PLEASURE BOAT

Complete in duplicate, retain copy and forward original to:

Ontario Water Resources Commission,
Division of Sanitary Engineering,
Watercraft Pollution Control Program,
801 Bay Street, Toronto 5, Ontario.

This application shall be made by or on behalf of the owner (owner includes a lessee) of the boat and the device described herein.

A. .... Tel. No. ....
(Name of Applicant — Please Print)

.... Age ....
(Permanent and temporary, if any, address of Applicant — Please Print)

B. **DESCRIPTION OF BOAT**

Model Name or Number .... Mfr. ....

Outboard........ Inboard........ Sailboat........ Other ....

Length Overall ....Ft. Beam (Max.) ....Ft. H.P. ....

Hull Material: Wood........ Aluminum........ Fiberglass........ Other ....
type

No. of Berths............ (convertible or otherwise) Passenger Rating ....

Licence No. .... Registered No. (if applicable)............ Registered Name ....

C. **TYPE OF DEVICE**

1. Storage device requiring dockside pumping to remove contents ....
2. Storage device equipped with pump to empty contents ....
3. Portable container for manual emptying ....
4. Other ....
(Type)
5. Treatment device intended for overboard discharge ....

(Where a device mentioned in item 5 is to be used, a temporary permit that expires June 1, 1971 is required).

D. **MODEL FEATURES**

1. Model Name or Number ....
(Manufacturer)
2. Has Device been subjected to tests covering design, construction, installation and operating characteristics? .... Yes .... No
3. Name and Address of Testing Agency ....
4. Attach results of or information relating to such tests to application.
5. Is permanent placard with operating instructions provided with the device? .... Yes .... No
6. Is a chemical additive used in the operation of the device? .... Yes .... No
7. Name of chemical to be used............
8. Is a tracer dye added in the operation of the device? .... Yes .... No
9. Name of tracer dye to be used............
10. Is device a self-contained recirculating type? .... Yes .... No

11. Is device recirculating with head and storage tank separate? .... Yes .... No

12. Number of usages between recharge cycles ....

13. Initial charge ....Imp. Gal.

14. Total capacity ....Imp. Gal.

NOTE: Please attach specifications for device together with operating instructions.

E. HOLDING TANK

Holding tank material ....

2. Capacity ....Imp. Gal.

3. Diameter of inlet opening ....inches

4. Diameter of outlet opening ....inches

5. Diameter of piping from toilet to holding tank ....trade size inches

6. Diameter of piping from holding tank to pump-out connection .... trade size inches

7. Diameter of pump-out connection ....trade size inches

8. Material for piping ....

9. Is holding tank provided with sewage level indicator? .... Yes .... No

10. What provision is made in the design of the holding tank for cleaning the tank and piping? ....
....

F. TREATMENT DEVICE FOR A PLEASURE BOAT FROM A JURISDICTION OTHER THAN ONTARIO

If the owner of the pleasure boat is from a jurisdiction other than Ontario, please complete this section.

1. Address where applicant is ordinarily resident ....
Address in Ontario, if any ....

2. Does the device for the storage, treatment or disposal of sewage in your boat comply with the laws of the jurisdiction in which the applicant is ordinarily resident? .... Yes .... No
If the answer is yes, please enclose documentary evidence of the compliance referred to.

3. Is the pleasure boat registered or licensed in the jurisdiction in which the applicant is ordinarily resident? .... Yes .... No

4. Has approval of the device described herein in the jurisdiction in which the applicant is ordinarily resident ever been refused, suspended or cancelled? .... Yes .... No

5. Is the pleasure boat being or to be operated in Ontario water and if so which water? ....

I certify that the information in this application is true, complete, and accurate.

Name of Applicant .... (Please Print)

Signature of Applicant or of Authorized Officer or Agent thereof ....

Name and Title of Authorized Officer or Agent ....
.... (Please Print)

Dated at ....this..........day of ....19....

AFFIX
CORPORATE
SEAL

STATE WATER QUALITY CONTROL BOARD
47 Trinity Avenue, S.W.
Atlanta, Georgia 30334

December 15, 1967

Mr. Joseph B. Stinson
The Joseph B. Stinson Company
406 Justice Street
Freemont, Ohio 43420

Dear Mr. Stinson:

In reply to your letter to Mr. R. S. Howard of December 13, the Georgia Water Quality Control Board acknowledges receipt of the plans and literature for your "Jonny Trap" marine holding tank system and your coin operated pump.

After reviewing this literature it is my opinion that the abovementioned equipment will meet the requirements of Chapter 730-4 of the Rules of the State Water Quality Control Board when properly installed. However, the coin operated pump should be installed only at those locations with approved on-shore disposal facilities.

The Georgia Water Quality Control Board

is pleased to see new equipment in the field of marine sanitation. There is a need for such a system as yours at present and this should increase with greater demand to be placed on Georgia's recreational water in the future.

Sincerely,
(Signed) Marshall Gaddis
Marshall Gaddis
Marine Technologist

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COMMONWEALTH OF VIRGINIA

STATE WATER CONTROL BOARD

P. O. BOX 11143 Richmond, Virginia (703) 707-2241

January 4, 1968

Mr. Joseph B. Stinson, President
The Joseph B. Stinson Designers
and Builders of Automation Equipment
406 Justice Street
Freemont, Ohio 43420

Dear Mr. Stinson:

This will acknowledge your letter of December 13, 1967, requesting a statement of consent from our office to permit the sale of your marine sewage holding tank system in the State of Virginia. As you are aware, we have no authority to approve the selling of any manufactured equipment.

As you are also aware, we have no laws in Virginia concerning control of pollution from individual boats and are in no position at the present time to approve or disapprove any pollution abatement devices for boats. However, we do not offer any objections to your selling these devices in Virginia, and the staff would recommend your system for approval by the Board, should any law be passed that would make us the responsible agency for approving such facilities.

Very truly yours,
(Signed) Charles E. Cooley
C. E. Cooley, Director
Pollution Abatement Division

CEC/mjs

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FLORIDA STATE BOARD OF HEALTH

Jacksonville

November 22, 1967

Waste - Marine Toilets / 47

Mr. Joseph B. Stinson
President
Joseph B. Stinson Company
406 Justice Street
Fremont, Ohio   43420

Dear Mr.Stinson:

Your inquiry of November 11, in regard your products "Jonny Trap" and "COP" is acknowledged. The Board of Health does not presently have specific legal control or regulations on marine toilets. State law and Board of Health regulations do prohibit the pollution of surface waters and any equipment or device which would adequately prevent pollution from toilets on boats could be sold and used without objections. We would be most favorable to the principle of a holding tank with discharge to marinas properly equipped for that purpose.

The board does not endorse for sale or advertising purposes any particular equipment, but offers no objections to its use if adequately designed for the purposes intended.

Yours very truly,
(Signed) Charles E. Cook
Charles E. Cook

CEC:jb

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STATE CONSERVATION COMMISSION
East 77th and Court Avenue
Des Moines, Iowa 50308

December 5, 1967

Joseph B. Stinson Company
406 Justice Street,
Fremont, Ohio 43420

Dear Sir:

In reference to your letter regarding a sewage holding and discharge system.

It is against Iowa law to discharge raw sewage in Iowa waters. We do not at this time, however, have a law covering an approved system on holding or disposal units. In any future proposed legislative asking's I'm sure we would be for holding tanks rather than a treatment discharge type installation.

If we can be of further assistance please feel free to call on us.

Very truly yours,
(Signed) Lewis M. Boers,
LEWIS M. MOERS, Supv.
Waters Section

LMB:cp
cc: file

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STATE OF KANSAS

FORESTRY, FISH AND GAME COMMISSION

Box 1028

Pratt, Kansas 67124

November 6, 1967

Mr. Joseph B. Stinson
President
The Joseph B. Stinson Co.
406 Justice Street
Fremont, Ohio 43420

Dear Mr. Stinson:

In reply to your letter of October 31, we are not in a position to approve or disapprove your product called the "Jonny Trap". There is no fish and game regulations concerning this matter but the State Health Department does control the type of sanitary facilities that can be used around public waters, and the State Park Authority controls the type of apparatuses that are under the jurisdiction of concessionnaires. In some cases these concessionnaires may be under the supervision of the water controlling agency in which case it is usually the Corps of Engineers or the Bureau of Reclamation.

In the few cases where concessionnaires are located on Fish and Game Lakes, we do have control but it would be up to the concessionnaire to maintain and operate such facilities. Before he can install additional facilities he must have an approval from this Department giving us the details along with specifications and so forth, so that we can better judge its merit.

I would suggest that you contact the State Department of Health, State Office Building, fifth floor, Topeka, 66612, regarding the feasibility and the approvability of such equipment; and I would also contact the State Park Authority, 801 Harrison, Topeka, 66612, regarding the installation of such equipment on areas under their jurisdiction.

Yours truly,
(Signed) Geo. C. Moore
GEORGE C. MOORE
Director

GMC:es

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J. B. STINSON

STATE PARK AND RECREATION COMMISSION

STATE OF NEW MEXICO

November 14, 1967

Mr. Joseph B. Stinson, President
The Joseph B. Stinson Company
406 Justice Street
Fremont, Ohio 43420

Dear Mr. Stinson:

Thank you for your letter dated October 31, 1967, regarding the marketing of your products, the "Jonny Trap" and "COP's".

We are certainly happy to hear that these systems are available to boaters. However, New Mexico has not yet reached a decision regarding the use of toilet facilities on boats. When this problem is resolved and law is passed, we would perhaps be in a position to approve or disapprove the installation of your product aboard watercraft in New Mexico.

Sincerely,
JAMES L. DILLARD
DIRECTOR
(Signed) C. E. Rouch
BY: C. E. ROUCH
ADMINISTRATIVE OFFICER

CER/lyw

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STATE OF RHODE ISLAND AND PROVIDENCE PLANTATION

DEPARTMENT OF HEALTH

November 7, 1967

Mr. Joseph B. Stinson, President
The Joseph B. Stinson Co.
406 Justice Street
Fremont, Ohio 43420

Dear Mr. Stinson:

Your letter of October 31, 1967, regarding the "Jonny Trap" and "COP's", to Mr. Charles G. Bolwell, Chief, Division of Enforcement, has been referred to this office.

We would be happy to receive any literature you have pertaining to your products; however, we do not give approval for general use or endorse any product. Any proposal to utilize this equipment at a specific location would be reviewed and approved only for that specific location if the facilities were found to be adequate.

Yours very truly,
(Signed) Carleton A. Maine
Carleton A. Maine, Chief
Div. of Water Pollution Control
Department of Health

CAM:mm

cc: Charles G. Bolwell, Chief
Division of Enforcement

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STATE OF WYOMING
GAME AND FISH COMMISSION
CHEYENNE 82001

November 3, 1967

Joseph B. Stinson, President
The Joseph B. Stinson Company
406 Justice Street
Fremont, Ohio 43420

Dear Mr. Stinson:

At the present time we do not have a law demanding or prohibiting any facilities for handling wastes on our boats.

We have not asked our legislature for a "marine head" law, but we anticipate doing this in conjunction with our State Department of Public Health and this will be done when the criteria is drawn up for the water quality standards for this state. We do have waters that rest within National Park boundaries that prohibit the discharge of any wastes into the waters.

Our legislature will not convene until 1969 and at that time we will have a law submitted to them for their consideration.

Sincerely,
(Signed) William S. Kozas
William S. Kozas
Watercraft Officer

WSK/blw

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MICHIGAN SOCIETY OF PROFESSIONAL ENGINEERS

533 South Washington

Lansing, Michigan 48933

Please address reply to:

Dow Chemical Company
Plant Engineering
464 Building
Midland, Michigan 48640

January 22, 1968

Mr. Loring F. Oeming,
Executive Secretary
Water Resources Commission
200 Mill Street
Lansing, Michigan 48926

Dear Mr. Oeming:

MICHIGAN SOCIETY OF PROFESSIONAL ENGINEERS

FEDERAL CONFERENCE ON POLLUTION OF LAKE MICHIGAN AND ITS TRIBUTARY BASIN

In answer to your letter of December 29, 1967 to Mr. John J. Carey, President of the Michigan Society of Professional Engineers, we take this opportunity to thank you for requesting our participation in this Conference. It is certainly a project which is worthy of immediate action and which affects a wide area of central United States. The statement which I am attaching is the policy issued by the National Society of Professional Engineers. This is also the policy of the Michigan Society of Professional Engineers and we hope it will supply you with the facts and views of the Michigan Society of Professional Engineers.

Should you desire any further information or comments, please feel free to call or contact me.

Sincerely,
(Signed) Clair H. Aiken, P.E.
Clair H. Aiken, P.E.
Vice President, M.S.P.E.

Enc. (1)

MICHIGAN SOCIETY OF PROFESSIONAL ENGINEERS

cc: Mr. John J. Carey, President, M.S.P.E.
3486 Woodland Road
Ann Arbor, Michigan 48104

ibe

MICHIGAN SOCIETY OF PROFESSIONAL ENGINEERS
533 South Washington
Lansing, Michigan 48933

January 22, 1968

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS
POLICY 46-B--WATER POLLUTION

The pollution of the streams, lakes and other waters of the United States is a serious problem which requires continuing attention. In accordance with the principle expressed by the National Conference on Water Pollution held in 1960, NSPE believes that the goal of pollution abatement is to protect and enhance the capacity of water resources to serve the widest possible range of human needs. The Society considers that this goal can be realized most effectively through a positive policy of providing the

MICHIGAN SOCIETY OF PROFESSIONAL ENGINEERS

best possible water quality consistent with engineering and economic factors and the public interest.

The Society recognizes that the primary responsibility for preventing and controlling water pollution rests with state and local governments. The exercise of Federal responsibility, with respect to international, interstate and navigable waters, should recognize state rights regarding pollution control. Federal aid, when necessary, should be designed to supplement non-Federal efforts , and the programs of Federal financial aid should be administered through appropriate state and local agencies and the existing facilities of Federal agencies with responsibilities for water pollution prevention.

The Society considers the current Federal water pollution control laws to be consistent with the foregoing policy. Any future revisions in these laws should preserve the existing Federal-State relationships.

The Society considers that granting authority to any Federal agency to establish and promulgate water quality standards would be contrary to the NSPE policy of preserving proper Federal-State relationships. The Federal Government should provide research and technical assistance to facilitate the establishment of water quality criteria by the states.

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MICHIGAN SOCIETY OF PLANNING OFFICIALS
1937 Cromwell Drive
Holt, Michigan 48842

January 16, 1968

Mr. Loring Oeming
Executive Secretary
Water Resources Commission
200 Mill Street
Lansing Michigan

Dear Mr. Oeming,

The Board of Director's of the Michigan Society of Planning Officials, at its regular meeting on January 12, 1968, went on record as favoring in total any efforts to control water pollution in Lake Michigan and its tributaries. It regrets that it cannot send an official MSPO Board member to voice its endorsement in person at your conference scheduled for January 31, 1968.

The Board also asked me to express to you, on its behalf, their appreciation for keeping them informed on the status of programs sponsored by the Water Resources Commission. The cooperative efforts made by the Commission are very much appreciated.

Sincerely,
(Signed) Bruce C. Brown
Bruce C. Brown
Executive Secretary

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STATEMENT BY MICHIGAN PESTICIDE COUNCIL
FOR
WATER POLLUTION CONTROL ENFORCEMENT CONFERENCE
CHICAGO, ILL., JAN. 31, 1968

The Michigan Pesticide Council has as its purpose the taking of such action deemed necessary to protect or restore the quality of our environment through the control of pesticides. This council is composed of representatives of ten organizations with a membership of over 65,000 citizens distributed over the entire state of Michigan.

The application of the pesticides DDT, dieldrin, and related chlorinated hydrocarbon insecticides over and on the lands and waters of the watershed of Lake Michigan during the past two decades, and the subsequent movement of these chemicals downstream into the lake, have brought about a serious state of contamination of its waters. The success of a twenty million dollar investment in establishment of the coho and chinook salmon in Lake Michigan is in jeopardy. The bald eagle, our national emblem, has virtually disappeared from its shores as a nesting bird. Reproduction in colonies of herring and ring-billed gulls, essential scavengers of the lake shore, has been impared.

We realize that pesticides are but one of many forms of pollution with which Lake Michigan is afflicted. We believe that all forms of pollution are significant, and call upon duly constituted authority to halt further pollution of the waters of Lake Michigan with these persistent chlorinated hydrocarbon pesticides by ordering to cease and desist from the use of the named pesticides, the following:

(1) all municipalities using DDT in Dutch elm disease control programs,

(2) all municipalities and public agencies using DDT in mosquito control programs, and

(3) all public agencies using dieldrin and similar chemicals in widespread insect control programs such as for the Japanese beetle.

We highly approve the action now being contemplated to clean up Lake Michigan, but consider it long overdue. We urge immediate, prompt, and vigorous measures before it is too late.

(Signed) Norman Spring
Norman Spring, Chairman
MICHIGAN PESTICIDE COUNCIL
1416 Lake Avenue
Grand Haven, Michigan

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MICHIANA WATERSHED, INC.

BERRIEN COUNTY CHAPTER

STATE OF MICHIGAN

MICHIANA WATERSHED, INC.
2010 Bond Road, Niles, Mich.

January 26, 1968.

Mr. Loring Oeming
Michigan Water Resources Commission
Lansing, Michigan

Dear Mr. Oeming:

We are pleased to know that you will represent the State of Michigan at the interstate conference on water pollution of Lake Michigan at Chicago on January 31.

As a priceless water resource of our State, our organization is vitally interested in preserving the purity of the waters of Lake Michigan for the present and future generations use and enjoyment. We ask that you accept this letter as proxy vote for our membership of 186 persons on your behalf.

We hope particularly that in your presentation of the case for Michigan that you will emphasize the need for the improvement of water quality in the St. Joseph River which is one of the contributors to the deteriorating condition of Lake Michigan. Your files are amply supplied with authenticated information previously gathered by your own staff and Federal agencies and presented at hearings over the past years at Elkhart, Indianapolis and South Bend, Indiana, and Niles, Michigan, and we believe that the only point that needs to be made at this time is that there has been no improvement in the situation. As previously reported, the major source of pollution of the St. Joseph River is the waste water treatment plant of the City of South Bend, Indiana, which although recently constructed, is inadequate for the load imposed upon it.

As you know, South Bend has been ordered by the Indiana Stream Pollution Commission for the past three years to construct the improvements necessary to bring its waste water treatment plant up to acceptable standards, and the City of South Bend has completed engineering work and has plans ready to complete this work, which would be of great benefit to Michigan citizens and the citizens of other states bordering Lake Michigan. However, repeated applications for Federal funds which are available to assist in this project and are allocated by the Indiana Stream Pollution

MICHIANA WATERSHED, INC.

Board have been denied. As a result, no improvement has been made and the water quality of the St. Joseph River is as bad as when we first brought the matter to your attention in 1963.

We hope that your testimony at the forthcoming hearing, with proper emphasis, will result in prompt action being taken to improve the waters of the St. Joseph River.

Very truly yours,
(Signed) S. R. Dunnuck, Jr.
S. R. Dunnuck, Jr. Secy.
Berrien County Chapter

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MR. VOGT: Now, this morning, Mr. Chairman, I made reference to a statement which I had from Mr. Keith Wilson and which there was some indication that Mr. Wilson would be present to deliver this statement. Over the noon hour I learned that Mr. Wilson will not be present and that it is requested that this statement not be incorporated into the record.

Therefore, I request that the recorder not include this as a part of the record.

MR. STEIN: That will be done. So

ordered.

MR. VOGT: We are now at that point in Michigan's Presentation where the State Report will be presented. This will be presented in two parts by Mr. Ralph Purdy, the Chief Engineer of the Michigan Water Resources Commission, and by Mr. Donald Pierce, Chief of the Waste Water Section of the Michigan Department of Health.

I will ask Mr. Purdy to begin the presentation.

STATEMENT OF RALPH PURDY
CHIEF ENGINEER
MICHIGAN WATER RESOURCES COMMISSION

MR. PURDY: Mr. Chairman, Conferees, ladies and gentlemen.

Before entering directly into our report -- this need not be on the record, this part.

(Off the record.)

MR. PURDY: We are now ready to start on our report.

We have presented this report to the

Conferees and, Mr. Chairman, we would ask that the entire report be considered as a part of the record. We will not read it, needless to say, in its entirety today.

I would like to turn directly to the Preface, page xi.

PREFACE

This report contains information on the municipal and industrial waste disposal situation in the Michigan portion of the interstate waters of Lake Michigan and in the tributaries to Lake Michigan in Michigan. It delineates the statutes that provide the local units of government authority to build, own and operate waste treatment facilities. It delineates the State statutes for control of water pollution. It delineates the accomplishments that have been made in controlling pollution and the measures that are being taken to provide improved control. It also describes the uses being made of these waters and water quality conditions.

The report was prepared for presentation to the Conferees at the Federal Conference called by the Secretary of the Interior for their consideration and appraisal in (1) arriving at conclusions as to whether waste discharges originating from Michigan sources are endangering the health or welfare of persons in a state other than that in which the discharge or discharges originate, (2) determining the adequacy of measures that have been taken for abatement of pollution, and (3) determining the nature of delays, if any, being encountered in abating pollution.

The area encompassed by the report includes all of the Michigan portion of Lake Michigan and its tributaries.

All sources of municipal sewage and industrial waste discharges to surface waters are covered. The nature of waste treatment or control measures in effect are described and the state agency action to control pollution and evaluate accomplishments is related.

The files and records of the Michigan Water Resources Commission and Michigan Department of Public Health are the sources of information contained in the report. The employed staffs of both agencies collaborated in assembling the material and preparing the report.

Now, under Statutory Authority, Part A, we describe the authority for local units of government to build, own, and operate waste treatment facilities. Some nineteen statutes are listed. I only wish to point out number three, Act 342, Public Acts of 1939, which authorized counties to establish and provide connecting water, sewer and/or sewage disposal improvements.

Act 245, Public Acts of 1947, an act to regulate the ownership, extension, improvement and operation of public water and sewage disposal systems lying within two or more public corporations.

Act 185, Public Acts of 1957, an act to authorize the establishment of a department and board of public works in counties.

Act 320, Public Acts of 1927, and this is a very important act in our pollution control program. It is an act to authorize legislative bodies of municipalities to issue and sell bonds necessary for the construction of sewage disposal plants whenever a court of competent jurisdiction shall have ordered same.

Act 373, Public Acts of 1925, is a companion act just as important and this is an act to authorize legislative bodies of municipalities to issue and sell bonds necessary for the construction of storm and sanitary sewers whenever a court of competent jurisdiction shall have ordered same.

Under part B, the authority for the control of water pollution, some twenty-one acts listed. On page 4 I would like to call your attention to number 8, Act 245, Public Acts of 1929. This is the act that created the Water Resources Commission to protect and conserve the water resources of the State, to have control over the pollution of any waters of the State and the Great Lakes, with power to make rules and regulations governing the same and to provide penalties for the violation of the act.

Number 10, Act 329, Public Acts of 1966, an act to provide State grants for sewage treatment facilities and to provide for administration of the grants by the water resources commission.

Number 12, Act 253, Public Acts of 1964, an act to enable local units of government to cooperate in planning and carrying out a coordinated water management program in the watershed. This is the act described to you by Mr. John Kennaugh this morning of the Grand River Watershed Group.

Number 13, Act 222, Public Acts of 1966, an act to provide for the exemption of industrial water pollution control facilities from certain taxes.

Act 98, Public Acts of 1913, an act providing for the supervision and control by the director of the department of public health over sewerage systems, and providing penalties for violations.

Number 17, Act 288, Public Acts of 1967, an act to regulate the subdivision of land; and to promote the public health by providing authority to the department of public health to approve subdivisions not served by public sewers on basis of suitability of soils.

Under the statutes that we have cited, we believe that it provides a basis for Michigan communities to do whatever is required in the way of abating pollution, and also the acts have been provided to enable the State and other regulatory agencies to require the necessary pollution abatement facilities.

On page 5, starting in on the Legal History, I will not go through all of this. To brief it very quickly:

In 1929 the Michigan Legislature enacted the Stream Control Commission Act, Act 245, establishing a 5-member Commission consisting of the Director of Conservation, the State Health Commissioner, the Highway Commissioner, the Commissioner of Agriculture and the Attorney General.

This Commission issued many orders. One in particular was appealed to the Court and the constitutionality and authority of the Stream Control Commission to issue orders requiring the abatement of pollution of the waters of the State was reviewed in City of Niles versus Stream Control Commission. This was decided March 11, 1941. In the course of that decision the Court made some notable objections, among which is the following:

> "In order to stop pollution of the river, it was necessary for the Commission to take action against the City of Niles, inasmuch as it was the first city in the State on the course of the river below the Indiana cities and thus opened the way for suit to compel the Indiana cities to stop pollution of the waters of the river. It is an instance where the state must clean up its own dooryard before being in a position to ask or seek to compel its neighbor to clean up. This was not an arbitrary exercise of power by the Commission but a practical movement toward accomplishment of a most desirable end."

The most notable series of cases involving the enforcement of an order of the Commission was against the City of Port Huron. This was issued February 11, 1936. The city failed to comply with this order and the Commission filed a bill of complaint on December 9, 1939, to enforce it. The Circuit Court denied the relief sought by the Commission and the matter was appealed to the Supreme Court.

The Supreme Court reversed the decision of the lower court and validated the order of the Commission. The Supreme Court referred to the agreement made by the city that construction of the sewage plant would not materially reduce pollution in the river. In disposing of this contention, the court stated:

> "The record contains sufficient testimony to substantiate the State's contention that the present raw sewage disposal method is a constant menace to the health and well-being of the down-river communities as well as to tourists. This evidence clearly justifies the Commission's order. Under the authority of the City of Niles case, supra, where similar arguments were advanced, it is no defense to a statutory charge of river-water pollution that others have or are contributing to that

condition."

The City of Port Huron failed to comply with the order of the Supreme Court, and consequently the Attorney General filed a motion for final process to enforce the decree. The court stated that the injunctive relief sought by the motion of the Attorney General will be granted in October of 1950, but even this did not end the controversy because the City of Port Huron experienced difficulty in selling the bonds to raise the money for the construction of the sewage treatment works.

I pointed out to you Act 320, Public Acts of 1927, under the statute section, that this authorized the legislative bodies of municipalities to issue and sell bonds necessary for the construction of sewage disposal plants "whenever a court of competent jurisdiction in this State shall have ordered the installation of a sewage or garbage disposal system in any of the governmental agencies or municipalities here mentioned and the plans therefore shall have been prepared and approved by the State Commission of Health." After reviewing the various authorities, the court held that whenever a municipality finds it necessary to raise money for the issuance of bonds for the purposes of complying with a court order involving the public health of the State, no referendum of approval by the people is necessary.

Another point raised by Port Huron was that the levying of the tax for the payment of such bonds would exceed the tax limitations provided by the city charter. This, by the way, is a contention which is usually made by municipalities whenever they are faced with complying with an order of the Water Resources Commission. In its opinion the court rejected this contention by holding that there is ample authority to levy taxes for the purposes mentioned in Act 320, and that even though the tax limitations were exceeded, such defense is not valid when the the city is required to comply with a court order.

The series of cases referred to has paved the way for enforcement of Water Resources Commission orders and has enabled Michigan municipalities to finance construction of projects necessary to comply with Commission orders. The

Water Resources Commission has secured court orders directing 26 units of government in the Lake Michigan Basin to abate pollution of the waters of the state by the construction of sewage treatment facilities and court action is now underway against 4 units of government.

Now, in addition, the Director of the Department of Public Health, acting pursuant to authority vested in him by Act 98, Public Acts of 1913, and Act 219, Public Acts of 1949, has prohibited the extension of municipal sewer systems and additional connections to existing systems where such is deemed necessary to control pollution and protect public health. The authority of the Director to so act has been upheld by Michigan court decisions.

Financial inability in the State of Michigan is not a defense against the abatement of a nuisance either by private citizens or by a municipal entity.

On page 11, Chapter II, under Pollution Control Program, and I will be following the text very closely here:

Administration of water pollution

control functions in Michigan necessarily follows the division of statutory responsibility set forth in the previously cited statutes subject to correlation, wherever possible, of member department interest and objectives with those of the Water Resources Commission. The Water Resources Commission and the Department of Public Health and their respective staffs carry the principal burden of water pollution control in Michigan at the state level.

WATER RESOURCES COMMISSION POLLUTION CONTROL PROGRAM

The goal and objective of the Michigan Water Resources Commission is to bring all existing unlawful pollution under continuing effective control and prevent the development of unlawful pollution from new sources, population growths, or increased industrial expansion and, where such incidents occur, limit their duration and intensity to the fullest extent consistent with requirements of the Water Resources Commission statute. Under the Michigan statute (Appendix A), it is unlawful for any person directly or indirectly to discharge into the waters of the state any substance which is or may become injurious to the public health, safety or welfare; or which is or may become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being or may be made of such waters; or which is or may become injurious to the value or utility of riparian lands; or which is or may become injurious to livestock, wild animals, birds, fish, aquatic life or plants or the growth or propagation thereof be prevented or injuriously affected; or whereby the value of fish and game is or may be destroyed or impaired. The discharge of any raw sewage of human origin, directly or indirectly into any waters of the state is prima facie evidence of a violation of the statute unless such discharge is permitted by an Order, rule or regulation of the Water Resources Commission.

Where inadequacies in control of waste discharges are determined to exist, an opportunity is provided for establishment of voluntary corrective action. When it appears to the Michigan Water Resources Commission that a voluntary program will not be successful or may not be accomplished within a reasonable time period, statutory procedures are initiated. Orders adopted contain specific effluent restrictions and specific dates for approval of construction plans and specifications, awarding of construction contracts and commencement of construction, and the completion of construction and attainment of pollution abatement as required by the Order.

Sewerage systems must be developed on the basis of separate sewers for stormwater and sanitary waste water. When at all feasible, separated sanitary wastewater systems shall not be discharged into combined systems. If such discharge does occur, control facilities must be developed on the combined system so as to protect present and future water uses of the receiving waters consistent with the requirements of the Water Resources Commission statute. Problems associated with the overflow of storm and sanitary waste from existing combined sewerage systems to public waters must be corrected.

Nutrient discharges, particularly with respect to phosphates, to public waters must be controlled. Persons proposing to make a new or increased use of waters of the state for waste disposal purposes are required, coincident with the new or increased use, to utilize such technology and processes which are known for the removal of phosphorus compounds and as a long-term objective, all existing waste discharges will be required to provide facilities for the removal of phosphorus compounds by June 1, 1977.

The discharge of sanitary waste from recreational watercraft will be controlled by rules and regulations to be adopted by the Water Resources Commission. Proposed rules and regulations (Appendix B) have been presented at a public hearing and final action is scheduled prior to June 1, 1968.

I believe, Mr. Chairman, that this is a very outside date and that final action will be taken prior to that time.

The Michigan Water Resources Commission will prevent the development of new problems by continued implementation of Section 8 (b) of its statute which requires the filing of a statement of use by any person proposing to make a new or substantial increase in use of waters of the state for waste disposal purposes. The Commission, upon receipt of a statement, makes an Order stating such minimum restrictions as may be necessary to guard adequately against unlawful uses of waters of the state.

Water quality standards for water uses of all inter- (Appendix C) and intrastate (Appendix D) waters have been adopted. Water use designation, together with a plan of implementation and enforcement of the standards have been adopted for the interstate waters. Public hearings are now being held prior to the designation of waters uses for the intrastate waters. All public hearings will be completed by November 1, 1968. Designation of all water uses to be protected by the intrastate standards within the state is scheduled to be completed by January 1, 1969.

On interstate waters, where noncompliance with the standards is determined to exist as the result of a discharge from an existing municipal wastewater treatment plant, treatment facilities adequate for meeting established water quality standards must be provided no later than June 1, 1972. Secondary treatment is required as a minimum unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with present and future water uses. Exception to the requirement for at least secondary treatment must be justified to the satisfaction of the Michigan Water Resources Commission and the Federal Water Pollution Control Administration. Presently identified existing discharges of raw sewage of human origin to public waters must be corrected by June 1, 1972. Year-round disinfection of all final effluents from municipal sewage treatment plants is required. Industrial waste discharges must meet the same effluent requirements as municipal waste effluents and industrial waste problems identified in the interstate plan reports must, no later than June 1, 1970, have adequate treatment or control facilities. Problems associated with the overflow of storm and sanitary waste from existing combined sewerage systems must be corrected no later than June 1, 1977.

The Water Resources Commission staff inspects each incipient pollution problem regularly. All Orders now adopted by the Commission, to both industries and municipalities, require routine analysis and reporting of the quality of wastes discharged to public waters. In addition surface water quality and waste effluents are monitored so as to identify the need for corrective action to abate existing problems and whenever possible so as to detect and identify the approach of pollution conditions in time to initiate appropriate corrective action prior to the development of a statutory injury. The Water Resources Commission staff reviews and approves or rejects plans for industrial waste treatment or control facilities and counsels with management on industrial waste treatment or disposal problems. It develops appropriate restrictions and time schedules for Commission approval to correct or prevent pollution problems and participates in enforcement procedures initiated by the Commission through statutory hearings and enforcement of Commission Orders in court when voluntary compliance is not forthcoming.

Mr. Vogt, I would like to interrupt my part of this presentation at this time now to have Mr. Pierce present the Department of Public Health and Pollution Control.

MR. STEIN: Before Mr. Pierce appears, we may take a recess.

I want to tell you about that noise in the back. I guess you were a backdrop for a TV show. You are the first guy here I know who could compete successfully with that Corps of Engineers Map. I guess that is a compliment.

(Laughter.)

MR. PURDY: It ruined my ego to see all the television cameras leave.

MR. STEIN: By the time they get to you, you will be out of focus, though.

(Laughter.)

Maybe that guy who got lost in the Loop will be able to distinguish you.

(Laughter.)

We will stand recessed for ten minutes.

(Recess.)

MR. STEIN: Mr. Vogt.

MR. VOGT: Mr. Pierce, will you now please carry on with the State Report.

STATEMENT OF DONALD M. PIERCE
CHIEF OF THE WASTEWATER SECTION
MICHIGAN DEPARTMENT OF HEALTH

MR. PIERCE: Mr. Chairman and Conferees, ladies and gentlemen.

I shall plan to follow rather closely the prepared report except to supplement to some extent for the purpose of amplifying or illustrating a point.

The Department of Public Health, acting through its Division of Engineering, exercises supervisory control over all public sewerage systems. The Director of the Department is required by statute, Act 98, Public Acts of 1913, as amended, to "exercise due care to see that all sewerage systems are properly planned, constructed and operated so as to prevent unlawful pollution of the streams, lakes, and other water resources of the state". The companion statute, Act 245, Public Acts of 1929, as amended, defines unlawful pollution and authorizes the Water

Resources Commission to "establish such pollution standards for lakes, rivers, streams, and other waters of the state in relation to the public use to which they are or may be put, as it shall deem necessary". Such pollution standards and the water quality criteria relating to the public uses, currently being promulgated for both interstate and intrastate streams, provide the framework upon which decisions are made and actions taken in relation to the planning, design, construction and operation of all sewer systems and treatment works. Elements of this supervisory program include the planning and approval of facilities, control of operation, including the training and certification of operators, and the review of required operational reports from each plant.

Now, in the area of Facilities Planning and Approval.

1. Review engineering reports establishing the basis of design for projects involving collection and treatment of waste water and consult with the engineers and municipal officials on elements of the proposed design

prior to development of plans and specifications for the project, require modification of proposed design where appropriate and, when found to be satisfactory, approve same.

2. Review, approve or reject and secure changes in plans and specifications submitted for new municipal systems or for changes in existing systems, both for collection and treatment. No public sewerage system may be built or altered without specific approval by construction permit.

3. Conducts inspections to determine that construction of public sewerage systems conforms to approved plans and specifications.

4. Require reduction of overflows from existing combined sewer systems. Adoption of accelerated programs for effective control of overflows from such systems is strongly urged. Progress has been made in several communities by sewer separation.

5. Require municipal rather than private ownership of all sewerage systems serving the public in the belief that more dependable

and effective operation and overall pollution control is thereby assured.

6. Counsels with officials of municipalities and their consulting engineer agents as to the need and methods for collection and treatment of waste water.

7. Strongly encourage and, where appropriate, require the development of multi-community area planning to provide effective services and pollution control facilities utilizing sound management principles. Many such areas are currently served by an integrated system of sewers, interceptors, and treatment works. Others are being so planned in several areas. Examples are metropolitan areas whose core cities are Battle Creek, Benton Harbor, St. Joseph, Grand Rapids, Jackson, Kalamazoo, Muskegon and Traverse City.

I should point out here, parenthetically, that all of these communities lie within the Lake Michigan Water Basin, Watershed, and there are many other examples one might cite for the other major river basins.

8. Encourage the admission of industrial wastes in municipal sewerage systems where such wastes will not adversely affect the system and its performance in relation to effective pollution control.

9. Foster, encourage and assist communities in the adoption of effective and practical sewer use ordinances for the control of industrial wastes to be admitted to the sewerage system. In many instances, technical assistance and counsel is provided in the location, analyses and evaluation of wastes, particularly those toxic to biological treatment processes and in the development of effective corrective measures and controls. Examples are metal plating wastes at Cadillac, Ludington and Wyoming brought under effective control within the last year.

10. Encourage and, where appropriate, require communities to conduct studies, pilot or plant scale, to provide a dependable basis of design for unusual combinations of industrial and municipal wastes to be

treated where sufficient information is not available for design purposes. Such studies were made at Battle Creek for cereal products and paper mill wastes to be treated at the municipal plant. Similarly, require studies, either pilot or plant scale, to develop a basis of design where an extremely high degree of treatment is required. Such a study was completed last year at Jackson.

11. Encourage and assist communities to conduct studies to establish effective methods for removal of phosphates from their wastes at existing treatment works. Such studies were made at Lake Odessa and Whitehall last year.

12. Require facilities for removal of phosphates in the design of all new treatment works, consistent with the adopted policy of the Water Resources Commission, which has earlier been stated in the record here today.

13. Require expansion and improvements of municipal facilities, both for collection and treatment as present capacity is approached,

rather than wait until the facilities are overloaded before taking action. Approval of sewer extensions is withheld where additional loadings would exceed the capacity of the system until an acceptable program for relief is officially adopted. "Sewer bans" have been imposed in several such circumstances where approval of extensions of sewers have been denied for some time, up to a period of two years in some cases. Authority for such action has been tested and upheld in the courts.

14. Order changes in facilities or their operation when requirements of the statutes have not been met. Alternatively, cases involving deficiency in facilities are referred to the Water Resources Commission for action.

15. As agent for the Water Resources Commission, review, approve or reject plans submitted for new sewer systems, other than municipal, or for changes in existing ones.

16. Assist and encourage local health departments to effectively direct and control the

installation of private sewage disposal systems where public sewer systems are not available for connection.

17. Require construction of separate sanitary sewers for new community systems. And this policy and action has been in effect for some five years and in some cases longer than this.

Facility Operation - Supervision, Visitation

1. Require the effective operation of all treatment works, including pumping stations and sewer system appurtenances. This authority is directly conferred by statute.

2. Require all municipalities to submit reports monthly on the operation of treatment works. Standard report forms are provided by the Department and each municipality is advised as to the minimum information to be reported and the frequency (number of days per week) of reporting. Included are both physical data and laboratory analyses to establish loadings on the plant, performance of plant units, and the

volume and characteristics of the plant effluent. Such information is used to determine effectiveness of overall plant performance, deficiencies of component facilities, capacity reserves for additional loadings, and operational problems and shortcomings. Action is taken to assist in corrective measures and to require correction.

3. Supervise operation by on-site inspection, instruction and consultation with plant operating personnel. Adequate services of this nature requires visitation once during each three months on the average.

Operator Certification and Training

1. Require all municipalities to employ operators whose competency, for the particular job,that is, has been certified by the Department. By statute, it is mandatory that the person in responsible charge of the plant be so certified. Over 600 -- I will say parenthetically here that about 685 -- operators have been so certified on

the basis of education, experience, and written examinations. About 200 operators with plant experience are examined each year. A high percentage of applicants are certified operators seeking to establish qualifications for a higher plant classification, of which there are four classifications.

2. Conduct formal group training sessions to impart specific information related to effective operational control, to provide opportunity for exchange of information and experience and to provide incentives for self-study and development. Over 325 operators attend a 2-day meeting each year conducted by Department engineers and chemists. A series of four 5-day sessions in laboratory procedures involving chemical and bacteriological analyses are currently being conducted by the Department staff. Eighty operators who presently perform such tests at their plants are registered. Evening courses are held throughout the state for a 12-week period each year in either

mathematics, chemistry, or hydraulics as applied to wastewater works operation, in a cooperative program with other agencies and organizations. Special courses in process control, safety and related areas are sponsored with other groups.

3. Encourage operators to meet on a regular schedule, usually about once monthly, on their own initiative to exchange information on plant operational problems and experiences and to invite speakers to discuss selected subjects related to facilities design and maintenance, laboratory equipment, etc. About 10 such groups meet regularly with about 200 operators participating.

Disinfection Policy and Practice

1. Require all municipalities to disinfect the plant effluent before discharge to the surface waters of the state. This policy was adopted in January 1967.

I think, Mr. Chairman, with your permission, it might be of interest to read this policy statement, because there are a couple of points that I should like to bring out.

Pardon me. I will leave the rostrum to find the statement.

MR. STEIN: Yes.

Appendix E, in my copy we don't have one either.

Here we are.

MR. PIERCE: The Department policy letter on this matter was issued to all municipalities of the State on January 4. It reads as follows:

"For many years most communities and others operating sewage treatment plants have chlorinated their treated wastewaters before discharging them into our streams and lakes. This practice has provided a large measure of protection to the public health. Present trends in public need for higher water quality to permit increased use of our public waters for all forms of aquatic recreation and other uses involving intimate human contact require refinements in present practices for bacteriological control of treated sewage effluents and greater vigilance by those responsible for the operation of the facilities involved. Greater concentrations of people living close to lakes and streams, coupled with year-round recreation, including fishing in late fall, winter and early spring, requires continuous bacteriological control whenever sewage is discharged to the public waters. Seasonal chlorination during the summer recreation season no longer can be depended upon to provide a full measure of protection to the public health.

"It, therefore, is the declared and established policy that:

"All municipalities and others discharging treated sewage from sewage treatment plants to the public waters of the State be required to provide effective bacteriological control over the effluent therefrom by the continuous application each day of the year' -- and those words are here underlined -- 'continuous application each day of the year' of chlorine or other effective chemicals in facilities approved by the State Department of Public Health. Effective control requires sufficient testing at approved points of sample collection to assure the maintenance of an adequate residual of chlorine or other disinfecting agents, supplemented by occasional testing for organisms of the coliform group. Adequate disinfection should reduce consistently the concentration of coliform organisms to one thousand or less per hundred milliliters."

It is a source of great satisfaction to those of us who work on problems of this nature to be able to report to you today that so far as we can determine there is 100 percent conformity with this declared policy. Three weeks ago, I knew of one town that was still holding out and that was not chlorinating on a year-round basis, and I believe that one town is now in the bag and we are 100 percent.

MR. STEIN: Some of us, Don, have been waiting twenty years for this day, and I am glad to hear that Michigan is the first State to announce that they have done it. This is wonderful.

MR. PIERCE: Thank you. We are very happy, too.

At this point I should like to read, and to some extent discuss, studies made beginning last summer on removal of phosphates from waste water at municipal treatment plants. I am going on now with the script.

During the past year studies have been made by several Michigan municipalities on removal of phosphates from the waste water collected in their community sewer systems. Two general methods were utilized: One involving the addition of iron salts either to the raw sewage or activated sludge with or without the addition of polymers; the other involving management of the activated sludge process without chemical additions. The latter method is an extension and adaptation of the work conducted at San Antonio and other installations as reported by the Federal Water Pollution Control Administration. The central objectives of these studies were:

1. To determine phosphate concentrations and loadings at several municipal treatment plants.
2. To determine the amenability of wastes at various locations to phosphate removal by one or more methods in relation to primary sedimentation, trickling filters and activated sludge.

3. To explore the effect of chemical additions for phosphate removal on the removal of BOD and suspended matter at primary, trickling filter and activated sludge installations.
4. To study the degree of compatibility of iron salts with biological and chemical (polymer) treatment systems, when added for phosphate removal.
5. To furnish information upon which design of facilities for phosphate removal may reasonably be predicated.

Studies of this nature were prompted by:

1. The acute and pressing need to develop base line data for the design and management of facilities at several existing wastewater treatment plants for removal of a high percentage of phosphates from the plant effluents.
2. Preliminary studies by the Dow Chemical Company at the Midland, Michigan wastewater treatment plant in February 1967 -- that is a municipal plant there -- indicating that iron salts held promise for effective phosphate removal in both primary and biological treatment systems.

3. The need to apply the principles developed in the San Antonio, Texas, studies to individual, peculiar circumstances in order to determine how such principles might be applied effectively in the design of biological treatment facilities with a high degree of phosphate removal for such circumstances.

A variety of study methods and procedures were followed. Some involved bench studies only, using jar tests on the wastes undergoing treatment at the plant; others included full-scale plant operation applying the knowledge acquired in the bench work; and others were conducted at pilot plants built to establish a basis of design for facilities to be added.

The first of these studies was conducted at Grayling, a resort community of less than 2,000 resident population (Appendix F), and the second at Lake Odessa, the trickling filter plants. These two plants, selected for full plant scale study, were not selected on the basis of the excellence of the facilities for removal of phosphates by chemical methods. On the contrary, the facilities and the wastes to be treated were far from ideal, as detailed in the report in the Appendix. The plants were grossly overloaded for significant periods during the study and no formal facilities were available for the feeding and mixing of the chemicals with the wastes to be treated. Actually, these plants were selected for study because of the urgency for exploring methods for removal of phosphates from these particular wastes where phosphate build-up in the receiving waters are at critical levels today, one a major trout stream of national reputation and the other a small recreational lake.

Bench studies at Grayling indicated that 90 percent or more of total phosphates could be removed from the raw wastes by plain sedimentation with the addition of about 20 milligrams per liter of ferrous chloride, about 40 milligrams per liter -- your text says an equal amount, and this is incorrect; it is about 40 milligrams per liter -- of sodium hydroxide as calcium carbonate alkalinity, and about 0.5 milligrams per liter of an anionic polymer. It was indicated that the caustic could be added a few seconds following quick mix of the iron salt with the raw sewage and that a selected polymer, if added following an interval of about 5 minutes, would form a good floc after a short period of about ten to fifteen minutes of slow flocculation and would effectively remove the phosphates. A very low order of removal of total phosphates was experienced when no polymer was added. These principles were applied to full-plant scale operation within the limitations of the facilities. The iron and caustic were added to the sewage at the lift station with no formal mixing facilities and the polymer was added at the entrance to the settling tank with crude and temporarily rigged mixing equipment.

I might say here by way of explanation that the ferrous chloride was introduced as the sewage entered the lift station at the discharge of the incoming sewer. Then as it flowed across this small lift station and was pumped in a force main to the treatment plant, the caustic was added through a plastic tube into the force main. The force main had a contact time averaging about six minutes, actually varying from about four to eight minutes, and then the polymer was added in a rising box before discharge over three weirs into three separate settling tanks. The mixers were installed near the inlet end of the tanks. These were jerry rigged without actually any real provision for the slow flocculation that was determined by the bench studies to be necessary.

During much of the period of plant scale application, which was from June 20 to September 14, as detailed in the appendix, the plant was grossly overloaded hydraulically by reason of seasonal influx of tourists and a National Guard encampment connected to the community sewer system. Actually, the overflow rates in the settling tank ranged from about five gallons per square foot per day to some 2500, representing an overload at maximum flows of some three times. In spite of these adverse circumstances total phosphate removal ranged between 60 percent and 80 percent with a most probable mean value of 72 percent. Correspondingly, suspended solids removal ranged from 60 percent to 87 percent with a mean value of 78 percent representing an increase of about 27 percent compared with performance when chemicals were not added. Removal of 5-day BOD increased from a mean value of about 40 percent before and after the study to about 58 percent during the study. It should be noted here that the raw sludge was hauled to a land disposal site. Actually, this plant has a digester and ordinarily supernatant would have been returned, but they had some difficulty with the heating coils and it was necessary to abandon the digester some months before this study commenced. So these studies are without benefit of supernatant return.

The detail for all of the points for all of the test data are shown in figure III A, figure IV A and figure V A, should you wish to refer to this, on pages 86, 88 and 90.

Work of a similar nature, both in bench studies with jar tests and full-scale plant operation, was performed at the Village of Lake Odessa (Appendix G), and this report begins on page 95 of the appendix. Here the municipal treatment facilities include trickling filters and sludge digestion facilities. The same chemicals were applied to the raw sewage as at Grayling in about the same concentration except that the dosage rates of the ferrous chloride were less effectively controlled, resulting in rather widely fluctuating dosage rates, ranging from daily averages of about 15 mg/l to 60 mg/l. Actually the ferrous chloride was introduced at a constant rate and the rates of flow of the incoming sewage varied widely, about four to one. No mixing or flocculation equipment was installed. Wastes varied widely from day to day and week to week in strength and quantities by reason of changing admixtures of wastes from a food processing plant. Total period of the plant scale study both with and without chemical treatment was 87 days including 33 days when valid operating data were obtained under controlled chemical feeding conditions. These data generally confirmed Grayling observations although removal of total phosphates, 5-day BOD and suspended solids by primary sedimentation was somewhat lower. It was further indicated that:

1. Trickling filter performance is enhanced, as measured by 5-day BOD and suspended solids removal, by this regime of chemical additions to the raw sewage. Most probable mean values for overall plant suspended solids removal increased from

about 78 percent without chemical additives to about 89 percent with chemicals; Correspondingly, BOD removal increased from about 60 percent to about 80 percent.

2. Overall plant reduction of total phosphates was quite stable with values generally between 75 percent and 92 percent removal and a mean value of 82 percent.

3. Total phosphates in the digester supernatant were quite low with most values below 75 mg/1. This appears to confirm the findings of E. A. Thomas as reported in his published work conducted at the treatment plant for the community of Uster in Zurich, Switzerland.

Other work involving use of ferrous chloride and polymers was performed last summer at the Village of Whitehall and the City of Traverse City. The studies thus far have been bench scale, employing jar tests similar to those at Grayling and Lake Odessa. Results have generally confirmed the earlier findings at the other two plants. At Traverse City it is planned to explore further, by pilot plant studies, how to most effectively remove phosphates from their peculiar wastes in a biological treatment process requiring a high order of removal of BOD and suspended matter. The municipal sewage includes substantial quantities of wastes from cherry processing operations.

Rather extensive studies of phosphate removal by metallic ion precipitation in a biological system were commenced last September at the municipal activated sludge plant of the City of Warren. A pilot plant was installed as the first step in a study to establish a basis of design for extending the present capabilities of the plant to meet an effluent requirement of 8 mg/l 20-day BOD and 80 percent removal of total phosphates. Pilot plant components consist of activated sludge units followed by rapid sand filters. Ferrous chloride or aluminum sulfate were fed into the aeration tanks near their point of overflow at about 15 mg/l. No polymers were added. At the end of the first three months of daily operation and testing seven days a week of composite samples, it was established that:

1. Total phosphates precipitated by metallic ions were removed by activated sludge in the order of 70 percent or higher consistently and an additional 10 percent or more was removed by the rapid sand filters.
2. The addition of iron or aluminum directly in the mixed liquor for phosphate removal is compatible with the activated sludge process when operated for high degree BOD removal.

Other work of a pilot plant nature is being conducted by the cities of Detroit and Trenton under demonstration grants from the Federal Water Pollution Control Administration. Both projects utilize activated sludge. Data obtained will be used, hopefully, for the design of formal facilities to be added to the existing primary plants for improved treatment, including phosphate removal. The pilot plant at Detroit has a nominal capacity in excess of 100 gpm and is very flexible and adaptable to a wide variety of control patterns and methods. Both plants have been operating for about four months. Biologic methods utilized to date for phosphate removal conform generally with the San Antonio procedures. Although results thus far have not demonstrated a consistent high order of removal of phosphates, they are at this point inconclusive and indicate that much more work will be required to establish predictable patterns of phosphate removal by these methods on these wastes.

In addition to the specific installations which we have discussed here, there are many treatment plants in Michigan where tests have been performed to establish the level of phosphates in the municipal wastes, their variations and some of their specific characteristics. In some of these plants, jar tests have been made in the laboratory using chemical additives to determine amenability of the wastes and dosage rates required for phosphate removal. In others, preliminary jar test studies have been made on activated sludge without chemical additives. Similar studies are planned at several plants involving a wide variety of conditions, methods, procedures and objectives.

As each study progresses it will add in

some way to our knowledge of the mechanisms by which phosphates may be effectively and economically removed as a companion process to meet the overall treatment objectives now being established.

I should like to go back for a moment, Mr. Chairman, and comment on the indication of costs gleaned from the studies at Grayling and Lake Odessa, full plant scale studies.

In those particular circumstances where the total phosphates in the raw wastes were quite high, ranging at Grayling from 40 to 60 milligrams per liter and in Lake Odessa in the area of 30 to 50 milligrams per liter, these particular chemicals resulted in a cost of approximately, in the case of Grayling, three cents per thousand gallons, 30 dollars a million gallons; in the case of Lake Odessa, a little bit more than this, perhaps three and a half cents per thousand gallons.

This completes my portion of the report.

MR. STEIN: Thank you, Mr. Pierce.

At the request of the Michigan Conferees, Mr. Pierce has to get a plane soon, and I think that they have asked us to change their original requirement and ask that questions or comments on

Mr. Pierce's portion of the presentation be made now and withhold your comments or questions on the one made by Ralph Purdy. Mr. Purdy will return for an additional presentation.

MR. PIERCE: Thank you, sir.

MR. STEIN: Are there any comments or questions to Mr. Pierce?

MR. HOLMER: Mr. Pierce, you say three and a half cents per thousand gallons for chemicals?

MR. PIERCE: Yes.

MR. HOLMER: This does not include the cost of operation nor the removal of sludge? It is strictly the chemical costs?

MR. PIERCE: Yes, sir, strictly.

MR. HOLMER: I have one other that doesn't relate to this subject but to the certification of plant operators. We admire your system and have adopted it ourselves.

We do not certify industrial treatment plant operators. I noticed, or thought I did, in something Indiana said yesterday to the effect that they were in the business of certifying industrial plant operators. Is Michigan in that business too?

MR. PIERCE: No. No. Actually, one of the fundamental reasons for this is that under the statute requiring certification, this deals only with the public sewerage systems and does not relate to industrial establishments where they discharge directly to the stream. That statute is the Water Resources Commission Statute, differentiated from the Health Department Statute, and this does not contain such a specific provision.

I might say here, parenthetically, with Ralph Purdy's permission, that consideration is being given now by the Water Resources Commission to the establishment of such a system with respect to discharge of industrial wastes to the stream.

MR. HOLMER: With respect to the nutrient removal again, we note in the tables attached to, or that are a part of this record, differentiation between 9-hour sampling and 24-hour sampling. Is this a significant distinction that ought properly to lead us to some conclusions with respect to phosphorus rich versus less rich influent?

MR. PIERCE: I doubt it. Actually, we reported here for your benefit the actual period of the sampling. In our analysis of the difference in the raw waste in the performance during periods of full-day sampling as compared to 9-hour sampling, we were unable to identify any specific variations in the capability of chemical treatment for removal of phosphates, although there was a difference, obviously, in both rates of flow, average rates of flow during the period, and of phosphate concentrations. But the percent removal seemed to be independent of this, and this was observed also throughout the period as flow rates changed, as concentrations changed. But even though it was impossible here to regulate chemical additions in relation to phosphate concentration, there did not seem to be much difference in the percent of phosphate removal under any of these circumstances.

MR. STEIN: Are there any further questions?

MR. WISNIEWSKI: Mr. Chairman.

Mr. Pierce, on page 85 in your report,

with reference to the grayling situation, Appendix F, I guess. Yes, that is in Appendix F, page 85.

MR. PIERCE: I will depend again on my good friend Ralph here to find the page.

Yes.

MR. WISNIEWSKI: A glance at the percent removal of the total phosphates indicates that on the 24-hour sampling your results were consistently lower than they were on the 9-hour sampling and that they were in the range of possibly 60 to 70 percent, with most of them near the 60 range.

MR. PIERCE: Yes. You will notice here, however, that there is a great difference in the rate of flow during this period.

MR. WISNIEWSKI: Rate of flow was substantially lower during the 24-hour periods than during the 9-hour periods.

MR. PIERCE: Yes, correct.

MR. WISNIEWSKI: So you should have gotten better results.

MR. PIERCE: Well, actually, you will note that during the 24-hour sampling period that there was quite a variation. There were both low and high removals. And we thought that the extent of the data here, that the number of days of sampling was not sufficient to demonstrate conclusively one way or the other that there was a significant difference. Had all of the figures been low or all had been high, it would have indicated a clearer trend.

MR. WISNIEWSKI: The only thing I am pointing to here is that the 24-hour tests indicate that you never reached the 80 percent everybody talks about on the practical operation. If you will draw a straight line through there, it will hit at about 75 percent and you will find that there are one, two, three, four, five, six, below the 75 percent line.

MR. PIERCE: Well, this is correct. And also if you will look at the 9-hour sampling days, there are many of those days that were in the area of 60, 70 percent removal. But when you look at the total pattern of phosphate removal, taking all of those figures and treating them as a whole, on page 86, Figure III A, you will note here that the mean -- or the most probable or centering value for all of the data is 71.5 percent removal, ranging generally from about 65 to 80. That is four days when the removal was less than 60 percent, between 55 and 60, one day when it was better than 80.

Now, I should like to point out again here that in the Grayling circumstance that the plant was grossly overloaded during this period, that there were no normal and usual facilities for the feeding or mixing or the flocculation of the chemicals, and as a matter of fact, everything was working against the removal of phosphates, and that here, in spite-- the point that we are making here, very factually is that in spite of almost insurmountable obstacles in the removal of phosphates by this method, the mean value of removal of total phosphates was 71.5 percent.

MR. WISNIEWSKI: No, I think the times when you had the very high concentrations of the order of 74 to 79 milligrams per liter in the raw wastes were the times when you were getting these higher percentage removals of 80 percent, let's say, but this meant that you had left in your effluent at least 20 milligrams per liter of total phosphorus which you were discharging to the stream. When your concentrations were 30 milligrams per liter or under, your efficiency ran in the 50 to 60 percent range.

MR. PIERCE: We only had four days, as I just pointed out, that were under 70 percent removal.

MR. WISNIEWSKI: There is one other factor we note in the narrative, you indicate that there is a substantial increase in soluble iron in the effluent.

MR. PIERCE: This is correct.

MR. WISNIEWSKI: Did you notice any deposits of iron below the outfall from this treatment plant, any deposits in the stream at any point?

MR. PIERCE: No. No. But --

MR. WISNIEWSKI: Was there any increase in the cloudiness of the water?

MR. PIERCE: No. But this does not mean that this would not occur. Actually, there is a good deal of flow here with a fairly high velocity at this point. There is a great deal or quite a bit of turbidity in the effluent which would mask an appearance of this kind for such a short period.

MR. WISNIEWSKI: But the iron content was around 8 milligrams per liter, which is quite high.

MR. PIERCE: Averaged, I believe, about six, from about four to about eight.

MR. WISNIEWSKI: We don't like to talk in averages in Wisconsin. We like to take the worst condition and correct for that.

MR. PIERCE: Touché.

MR. STEIN: Mr. Poole.

MR. POOLE: I want to pursue this a little with Don. I was having a private conversation here, but did I hear you say that phosphates at Grayling were 48 parts per million or better?

MR. PIERCE: They went from 40 to 60 quite frequently.

MR. POOLE: How much did they run at the other place?

MR. PIERCE: Somewhere normally between 30 and 40 with departures from those values.

MR. POOLE: We must be accomplishing this removal without doing anything, then. I don't have any phosphates on our raw sewage, but I am looking at them here for East Chicago and Gary and Michigan City and Mishawaka and South Bend, and in the effluents they are running 6 to 8 parts per million, and I don't know what the raw sewage is. But the point I am trying to make, I had assumed that we were getting very little phosphate reduction through these just ordinary activated sludge plants. East Chicago uses some alum and they have been averaging three and a half parts in their effluent, which I suspect on the basis of what I have heard in the last few days is the benefit from the chemical.

But if our plants are not removing any substantial portion of phosphates, our fellows are either making a mistake in their determination of the effluents or we are talking about a much lower range of phosphates than you are.

And so I think I am prepared to follow along with Ted in that I am questioning now whether you have any justification for saying you can remove 80 percent of the phosphates on the basis of this work.

MR. PIERCE: Well, Mr. Poole, we have observed, in the studies we have made thus far in a number of places, that phosphate concentrations vary widely and often unpredictably from sewage to sewage. In Detroit, for example, the phosphate concentration is more on the order of 10, sometimes 15, sometimes lower than 10. At some other places we have found it at 15 or 20. This particular situation at Grayling is a resort community with an unbalanced number of laundromats, a great deal of detergents, and I can't explain what the reasons were at Lake Odessa. It may have had something to do with cleaning operations in connection with the canneries. But this we haven't got into.

Actually, here in our studies we have made these as preliminary investigations without selecting the places for the purpose of making an academic study, but rather for the purposes of solving a problem that existed.

These installations may not be at all typical. And I can't say whether the -- I can't predict whether we would have the same experience with other wastes under a wide variety of conditions, some with low phosphate concentrations, some with high and some with other constituents which might interfere with this. All we have to offer you today is the experience that we have presented here on these particular installations.

MR. POOLE: This has been most helpful and I am not going to turn this into a technical session, but I think you well appreciate, as do many of the rest of us, that you can start out with a BOD of a thousand or with a suspended solids content of a thousand and it is no trick at all to get a 90 percent reduction. But if you start out with a BOD of a hundred or a hundred twenty-five, then when you commence talking about a 90 percent reduction, why, it is a horse of a different color.

The only thing I am saying here now is that what I am interested in is a phosphate removal process that will take these sewages that apparently have 10, 12, 15 parts per million in the raw sewage and will give us the

80 percent reduction on that, because, as I indicated here, these are all preliminary figures and not over too long a period of time, but the highest result I have for the averages on any of them was eight and a half parts per million for one plant and it ran from three and a half up to eight and a half. So, I would assume that their raw sewage phosphates couldn't be over 12 to 15 or else the activated sludge process all along has been removing more phosphates than we have been giving them credit for.

MR. PIERCE: May I just say, Mr. Chairman, that thus far all of the studies that we have made, both in bench scale and in plant scale, have shown great promise of effective phosphate removal in connection with various processes. Certainly a great deal, or more studies needs to be made, and we plan to make such studies at a number of places in Michigan with a wide variety of conditions, and I would hope that if each of the four states would make equal studies and equal explanations that we might soon have a variety of conditions with experience that could be used as the basis for judgment.

MR. STEIN: Is there any other comment?

Mr. Klassen?

MR. KLASSEN: Mr. Chairman, just two questions for information.

Don, we recognize that Michigan has probably had as much if not more actual experience in the chlorination of sewage than any of the other states. This is the reason for my asking you these two questions.

Have you made any studies, are you concerned with, the possibility that in chlorinating our sewage from our modern industrial communities that we may be chlorinating hydrocarbons so we are ending up with chlorinated hydrocarbons that could be toxic in the stream? That is one.

The second one is along the same line in a little different area: That we may be building up a chlorine immunity to the pathogenic organisms in the sewage which later, if that same water is picked up and used for water supply, that chlorination of the water supply would not be bacterially effective.

And my reason for raising these two

questions, because I think there are two countries, Germany and England, do not chlorinate sewage based on these two reasons. I wondered what your experience has been in Michigan.

MR. PIERCE: Actually, I am afraid that I can't throw any light on those questions, as you might suspect. We don't have a good deal of apprehension about this, however.

We have no evidence to indicate that chlorinated hydrocarbons are creating problems in the stream, the receiving stream, but this doesn't mean that there may not be isolated problems. I think this is deserving of study.

And the other question, I think, is a speculative one and one that we can only conjecture about at this point.

And while I can appreciate the grounds for your question, I am afraid I can't help you.

MR. STEIN: I think we had some other comments. Unless you do. Do you want to ask something?

MR. VOGT: I would like to go back to Mr. Poole's comment about the phosphates in the effluent, say, at South Bend, where, Blucher, you mentioned that, as I recall it, South Bend does use some alum, or one of the plants.

MR. POOLE: East Chicago uses alum. Their average is three and a half against an average of the other plants, I would say, of about seven.

MR. VOGT: Don, didn't the work over at Warren indicate that alum did prove rather effective in removing or did help in removing phosphates in the pilot study that they conducted over there, that most of the time was spent on the use of the iron salts, but as I recall they also used alum for a short time and did find fairly good results with the use of alum, which would indicate that perhaps East Chicago, by the use of alum, is, in effect, helping the biological process in the reduction of the total phosphates?

MR. PIERCE: Yes, this is correct. They used alum for a short period, which they expect to explore further, and had about the same dosage rates and about the same results.

And there at Warren, incidentally, the phosphates ranged from about 15 to about 35 total phosphates.

MR. KLASSEN: I had one other question.

MR. STEIN: Yes.

MR. KLASSEN: Do you chlorinate the effluent from lagoons? And one of the staff here said that we noted that Texas exempts lagoons from chlorination. Apparently that was approved by the Department of the Interior.

Do you chlorinate lagoon effluents in Michigan, require it? We do in Illinois, and I just wondered whether you do.

MR. PIERCE: You always get to the bottom of it, don't you?

MR. KLASSEN: Lagoon is really pretty much at the bottom of it.

MR. PIERCE: No, actually, Mr. Klassen, we haven't chlorinated the effluent from lagoons as yet. We are exploring methods for this, recognizing that we have a special problem, particularly where we have a high concentration of algae.

But our lagoon operations in Michigan are strictly on a seasonal discharge basis for very, very short periods of time. We discharge only for about two weeks in late fall and two weeks after the ice has come off in the spring, so while this is less hazardous, perhaps, less reason for chlorination than a continuous discharge, it is something that we want to get to. And we are looking to the Federal Government, to the researchers and anybody else that can shed light on how to manage a lagoon effluent with effective disinfection.

We haven't swept it under the rug, but we haven't found a good way to do this for those two short periods of high rate discharge.

MR. STEIN: Are there any further questions or comments?

DR. BORUFF: Mr. Chairman, as a chemist, or maybe modified as an ex-chemist, the speaker's tables are in terms of phosphate PO_4?

MR. PIERCE: Yes, sir.

DR. BORUFF: Others, I believe Dr. Weinberger talked about parts per million of phosphorus. As a chemist I want to call attention that 30 parts per million of phosphate would be about 10 parts per million of phosphorus, so you have got to divide by about three, in case there is some confusion here regarding the methods of reporting.

MR. PIERCE: Correct. Thank you.

MR. STEIN: Thank you, Dr. Boruff.

Mr. Poole.

MR. POOLE: I was talking about phosphates and I assumed that was what Don was talking about. Am I correct?

MR. PIERCE: That's correct.

MR. POOLE: I had a question of Mr. Purdy, if we are discussing that part of it now.

MR. STEIN: No, no. We have to wait. We are just discussing Mr. Pierce's part.

MR. POOLE: All right.

MR. STEIN: Do we have any further comments or questions?

Mr. Poston.

MR. POSTON: I would like to ask Mr. Pierce if there were designed mixing facilities and facilities to add chemicals in the regularly--the plant designed to mix and receive chemicals and settle them out, wouldn't you expect appreciably better results than you got at

Grayling and Odessa?

MR. PIERCE: Yes. Yes, indeed. This is discussed briefly in the appendix in the reports.

We hope that within the year we may have some experience that will throw some light on this.

We have one chemical precipitation plant in Michigan in this basin, at Petoskey, which has good formal facilities and which they use during the summer months, adding chemicals for regular chemical precipitation plant. We want to do some work at Petoskey on the use of iron salts and on various other chemicals for the removal of phosphates, and we plan to go in there in March and to get a good month, month and a half of sound information on background without chemical feed, and then to go on with this for two or three or four months or perhaps longer, and explore what can be done with good formal facilities, with the addition of chemicals for phosphate removal.

This would give us a much better feel on what can be done and hopefully we will have a waste that is lower in phosphates.

MR. POSTON: That is all I have.

MR. STEIN: Do we have any more comments or questions? You had better ask Mr. Pierce now; he is going to leave.

(No response.)

MR. STEIN: Thank you very much, Don, for a very illuminating statement. We enjoyed it.

MR. PIERCE: Thank you, sir.

MR. STEIN: I think at this point we will call on Mr. Holmer again to accommodate someone from Wisconsin who asked to make a statement.

Mr. Holmer.

WISCONSIN PRESENTATION

MR. HOLMER: Mr. Stein, I appreciate the tolerance of the delegation from Michigan in allowing us twice to do this in the same afternoon.

We have been treated over the last several days to appearances by patient women from other states. The roll of women in the fight on pollution in which we are all engaged is a very important and significant one. The roll of The Izaak Walton League in our respective states in keeping the public awareness of the problem and helping us toward solutions is also well known.

We have from Milwaukee, Wisconsin, Mrs. Eugene Dahl, who fills in both capacities and who has been very helpful to the State of Wisconsin and to the Division of Resource Development in our water pollution effort. She is presenting a statement this afternoon on behalf of the Wisconsin Izaak Walton League, and it is a privilege for me to present to this audience and to my fellow Conferees, Mrs. Dahl.

STATEMENT OF MIRIAM DAHL
CHAIRMAN OF THE POLLUTION PROGRAM
WISCONSIN STATE DIVISION
IZAAK WALTON LEAGUE OF AMERICA

MRS. DAHL: Thank you, Mr. Holmer. And thank you for your very generous indulgence in allowing me to do this at this time.

Mr. Williams has the copies for everyone. I don't know where they are.

May I say at this point, while we are waiting to see if we have got the copies, that our approach to this problem has been on specification. We don't think that we are in the field of experts. We think that we are in the field of generalities and specification in the area of the goals which we want to reach.

I would like to say, too, that our goals are based on very definite specification, which if there is time and if you wish to hear them I would be glad to explain later, or if there are questions I will be glad to answer them.

Shall I begin?

MR. HOLMER: Yes.

MRS. DAHL: There should be copies coming.

Mr. Chairman and members of the committee, ladies and gentlemen, fellow conservationists.

The Wisconsin Division of the Izaak Walton League of America represents some 1500 members in 24 chapters situated throughout the State of Wisconsin. It is a democratically organized group of citizens who are sincerely interested in conservation and outdoor recreation and whose individual proposals when adopted are included in the Conservation Policies of the Izaak Walton League. This explanation is cited to show that the positions here taken are from the membership body and thus comprise a truly representative voice from concerned conservationists.

The long history of persistent and arduous work of conservationists cooperating with government and others has brought some gratifying results in good laws, concentrated research and a program of correction which is commendable. This is a good start.

We have the laws to do the job, but apathy remains firmly existent, wasting more of the too brief remaining time estimated necessary by our experts to do the job. We need to accelerate the implementation of corrections on a more rapid schedule. This is the reason we are here today. We believe a larger more closely coordinated effort is needed NOW.

We suggest that a working group representing government, industry, municipalities, the general public (who are now largely excluded) and conservationists from the Lake Basin area should meet with only ONE purpose -- to work on the problems of the LAKES area. ALL research data on the lake, including the lowest to the highest forms of life ought to be considered with regard exclusively for the best possible condition of the waters. This new approach could, with imagination, (the hidden ingredient of invention), reveal some new techniques in solutions of problems which have not previously been considered in the routine processes of attempted corrections. It could also offer real solutions instead of partial and "make-do" measures. The comparative economic value of full correction now instead of creating a need for more costly changes to meet the anticipated increase of existing problems in the future is evident to any thinking business executive or to any politician concerned with the tax structure.

The members of the Wisconsin Division of IWLA are not interested in a debate with industry nor with government. We do not wish to become involved with personalities or positions. We approach the problem (a huge one, we realize) of returning this priceless resource into a fine workable asset which will produce economically while also fulfilling the functions of life giving beauty and recreation. All of these goals can be accomplished with full use of all our expertise coupled with common sense and with a singleness of purpose not divided by personal or partisan problems which has, according to history, lost many causes and nations. We would hope to benefit from the lessons it teaches, for without the Lake resources -- imagine if you can, the results on our lives.

The above proposal is a NEW approach. This new overlook can reveal different ideas. Possible new solutions will come from such pertinent questions as "Is this necessary?" "What are the alternatives?" "What is the very lowest scale of life on which to begin correction?" "What is the economic value of doing the job right now as against stop-gap measures needing future correction?" "Are we thinking of the resource protection and wise use, or of a selfish, short-sighted purpose made to look benevolent?"

Let us not forget that we who comprise a very minute population of the world, are privileged to enjoy this magnificient gift. So many of us do not recognize or realize its magnitude and rarity because of the over-exposure of daily association. We have become callous towards this tremendous resource.

The Wisconsin Division of the IWLA urges an end to inaction and a firm move into an active program of implementing the laws which make it possible to reclaim our Great Lakes Basin area. We strongly urge further that this hearing be the catalyst for a strong active pollution elimination program beginning now. We have the authority. We have the technological ability. We have the research data necessary. There is nothing to stop us except our own indecisiveness. In the face of the rapidly increasing tempo of destruction, we cannot begin too soon to stop this despoilage and to reach our mutual objective of a Great Lakes Basin wisely used and wisely preserved.

The Wisconsin Division of The Izaak Walton League of America to the last member is ready and willing to help. We urge that action begin today.

Thank you.

And it is signed J. Michael Borden, who is President of the Wisconsin State Division of the Izaak Walton League of America. And I am the chairman on that level of the pollution programs.

MR. STEIN: Thank you, Mrs. Dahl.

(Applause.)

MR. STEIN: Are there any comments or questions?

(No response.)

MR. STEIN: If not, thank you very much.

MRS. DAHL: There are no questions?

MR. STEIN: There are none. Thank you very much.

Mr. Vogt, may we push on, please?

MICHIGAN PRESENTATION (CONTINUED)

MR. VOGT: We will return now to Mr.

Purdy, who will continue with the State of Michigan Report.

STATEMENT OF RALPH PURDY
CHIEF ENGINEER
MICHIGAN WATER RESOURCES COMMISSION
(CONTINUED)

MR. PURDY: Picking up on page 20:

CHAPTER III
DISCHARGES TO SURFACE WATERS

INDUSTRIES

The Water Resources Commission staff has under surveillance 231 industries which discharge treated or untreated waste water to public waters in the Lake Michigan Basin. The 231 industries that discharge waste effluents to surface waters are listed in Appendix H, and for just a moment I would like to turn to that to show the information that has been included in this.

We first show the industrial discharges to Lake Michigan, some 16 are listed, the company name, the product, its location, the treatment that is provided, the waste flow data where such is available, pounds of BOD per day, suspended solids pounds per day, the pollution status rating, which I will explain in a few moments, whether an order has been adopted and, if so, when, and certain other remarks that might be pertinent to that plant.

The pollution status ratings are updated annually and represent the Water Resources Commission staff's effort to fairly appraise each incipient pollution problem as indicated by a review of operating reports, observations, inspections or surveys during the preceding calendar year. The ratings are by letter code as follows:

A. Control adequate
B. Control provided - adequacy not established
C. No control - need not establish
D. Control provided - protection unreliable
E. Control inadequate
    c - construction underway
    p - plans being prepared
    s - studies underway

Table 1 summarizes the pollution status ratings of the 16 industries which have effluent discharges directly to Lake Michigan:

Table 1

Pollution Status Rating	Type of Industry					
	Chemicals	Electric Power	Food and Packing	Minerals	Paper	Total
A	2	3	2	2		9
B			1			1
B - Studies in progress					1	1
C						
D						
D - Construction in progress					1	1
E			1			1
No rating given		1	1	1		3
Total	2	4	5	3	2	16

As shown by the table, only 2 of the 16 have D or E pollution status ratings.

In addition to the 16 industries which have effluent discharges directly to Lake Michigan, 215 have effluent discharges to inland surface waters tributary to Lake Michigan. The pollution status ratings for these industries are summarized by tributary river basins in Table 2, 56 have D or E pollution status ratings.

GOVERNMENTAL UNITS

The 193 governmental units that discharge waste effluents to public waters are listed in Appendix I, together with the type of treatment provided, waste effluent data where such is available, abatement action taken and present status. And we have done this again for all of the discharges in the Lake Michigan Basin. The data was obtained from records of the Michigan Department of Public Health and the files of the Michigan Water Resources Commission. The waste effluent data reflects the average for the month of August 1967. Only 6 discharge their waste effluent directly to Lake Michigan. The remainder (188) discharge to various tributaries, some within a short distance from the lake and others several

Table 2
Summary of Industrial Surface Water Discharges in the Lake Michigan Basin
April 1, 1967

Pollution Status Rating, April 1, 1967 / River Basin	Menominee (U.P.)	Escanaba (U.P.)	Rapid (U.P.)	Pine	Elk	Boardman	Betsie	Manistee	Pere Marquette	White	Muskegon	Grand	Black Holland	Kalamazoo	Black S. Haven	Paw Paw	St. Joseph	Minor Drainage Areas	Sub Total	Total
A	6		1		2	1			2	1	7	19	2	17	2	7	8	3	78	
C Construction in progress																			0	
P Plans being prepared																	1		1	
S Studies underway					1			1											2	81
B	1					1	1		1		3	15	3	7		4	2	1	39	
C Construction in progress				1						1		2		3					7	
P Plans being prepared																	2		2	
S Studies underway					1			1			1			1					4	52
C										1		2					1		4	
C Construction in progress																			0	
P Plans being prepared																			0	
S Studies underway																			0	4
D							1		1		1	7	1	1		1	1		14	
C Construction in progress											1		1	1			4		7	
P Plans being prepared														1			1		2	
S Studies underway												2							2	25
E				2		2					1	1	1	7		1	1	1	17	
C Construction in progress												1		1					2	
P Plans being prepared								1			2	1	1	2					7	
S Studies underway		1										1	1	1			1		5	31
No Rating Given	1						1	3			4	11	3	4	1	1	6		35	35
Total	8	1	1	3	4	4	3	6	4	3	20	62	13	46	3	14	28	5		228*

*Note - The 228 status ratings summarized in this table reflect the ratings for 215 industries, 13 of which have dual ratings.

hundred miles inland.

The 6 with a discharge to Lake Michigan are:

Governmental Unit	Population	Treatment
Gladstone	5,400	Primary
Harbor Pointe	800	Primary (septic tank)
Harbor Springs	1,430	Primary (fine screen)
Petoskey	6,400	Primary (chemical precipitation)
Suttons Bay	420	Secondary (lagoons)
Wequetonsing	1,000	Primary (Imhoff tank)

You will note that they are all rather small, the largest with a population of 6,400. Approximately 2.3 million people live in the Michigan portion of the Lake Michigan Basin. A large percentage (43%) live in rural areas where collection and treatment of waste water by a central system is not necessary or feasible at the present time. They, in the most part, are served by individual systems, such as a septic tank followed by a subsurface percolation field. All but 4 percent of the population readily accessible to central systems are served by formal collection and treatment systems with approximately 72 percent of the population serviced receiving treatment by secondary biological processes. Fifty-three governmental units have been identified as permitting, allowing or suffering the discharge of raw sewage of human origin to public waters and in all instances the Water Resources Commission has, as a minimum, held an initial informal conference with the responsible governmental unit to discuss and encourage an appropriate water pollution abatement program. This initial action has been followed in 22 instances by formal statutory enforcement proceedings. The others are currently progressing satisfactorily but remain under continuing review.

In Chapter 4 we have described the Lake Michigan Basin and the water uses in the basin. I will not go through this in the interest of saving time this afternoon. I would like to point out, though, that some 650,000 people in Michigan use this as a water supply and that recreational use of our shoreline of 1,660 miles is very important to the economy of Michigan.

I would like to skip over now to page 32.

R. W. PURDY

CHAPTER V

PART I

THE RELATIONSHIP BETWEEN THE LAKE MICHIGAN ALEWIFE DIE-OFF AND RESULTING WATER QUALITY

Observations of depressed water quality conditions and increased bacteria counts concurrent with the annual alewife die-off along the Michigan shoreline of Lake Michigan led to a laboratory study of the problem (Appendix J). Six tubs, three containing Lake Michigan water and three containing Lansing tap water, were placed in an open area exposed to sunlight. Two of the tubs containing Lake Michigan water and two containing Lansing tap water each received one freshly dead 6-inch alewife. Chemical, bacteriological, and algal changes were monitored over the next 23 days, from August 16 to September 8, 1967. The dead fish provided an environment which allowed a population explosion of coliform bacteria. Decomposition of the fish tissues resulted in a nutrient release which in turn enabled a dense algal bloom to develop. Coliform and fecal coliform bacteria populations as high as 1,500,000/100 ml and 3,500/100 ml, respectively, developed in the tubs containing a dead alewife.

Abnormally high coliform bacteria populations developed along Lake Michigan beaches during the summer of 1967. The presence of dead alewives was probably a major reason for this abnormality. The high counts partially negate the value of beach bacteria sampling as an indication of sewage contamination.

Phosphate released from the decomposing fish in the tubs was rapid. Each single dead alewife in approximately 6.8 gallons of water released more than 2.0 mg/l soluble orthophosphate as PO_4 within two days. Soluble orthophosphate in these tests reached concentrations as high as 6.3 mg/l. The total phosphate released from these four fish during the test ranged from a low of 113 mg to a high of 201 mg PO_4 per fish.

In the tubs containing alewives, blooms of small single-celled, green algae developed shortly after nutrient release. In 1 case the algae population grew from less than 100 cells/ml to a maximum of 3,187,800/ml. These exploding populations utilized the available soluble orthophosphate. Concentrations of this phosphorus fraction dropped while total phosphate continued to increase.

One agency has estimated that a few hundred million pounds of alewives died in Lake Michigan during 1967. For the purpose of this report we will use 300 million pounds. Analytical work by the U. S. Bureau of Commercial Fisheries on several groups of alewives has shown that alewives about 6-inches long contain approximately 2.23 grams of phosphorus per pound of fish. Thus, 300 million pounds of dead alewives could release 2,300 tons of phosphates into Lake Michigan. The concentration of soluble orthophosphate as PO_4 commonly claimed sufficient to create nuisance algae conditions in water is 0.03 mg/l. If two-thirds of the released phosphorus was in the form of soluble orthophosphate the potential from this source alone exists to bring approximately 11 cubic miles of phosphorus-free water to the point nuisance algae blooms could occur.

It is generally acknowledged that during the summer the water mass along Michigan's west coast from Benton Harbor-St. Joseph to Little Point Sable is discrete and moves northward unless broken up by strong winds. The U. S. Bureau of

Commercial Fisheries aerial survey showed that most of the dead alewives were concentrated in the southern tip of Lake Michigan and in a band along both shores in the southern two-thirds of the lake. Windrows of dead alewives collect in the shallow water beach zone. Nutrients from the decomposing fish were released into this discrete, surface water mass which is already enriched by the tributary rivers draining urban and agricultural areas. There are 2,240,000 acre feet of water in Lake Michigan along the shoreline out to the 30-foot depth contour from the Indiana-Michigan state line to the tip of the Leelanau Peninsula. Assuming two-thirds of the phosphorus released during alewife decomposition is available for uptake then only 18,700,000 pounds of decomposing alewives would be necessary to bring that amount of phosphorus-free water to the critical nuisance-algal-producing level. This stretch of shore comprises approximately 20 percent of the total Lake Michigan coastline. Twenty percent of the estimated alewife die-off of 300 million pounds is 60 million pounds. It seems highly probable that more than the 18,700,00C pounds needed to bring the nutrient concentration to nuisance-potential levels would accumulate in this area.

Growing alewives concentrate phosphorus already present in the lake. It is normal for phosphorus to be recycled upon their death, but because of their unusually high population and habit of dying during a short period of the year in the alongshore waters, the phosphorus is released in a relatively small volume of water. It is concluded that phosphate released from decomposing alewives in the alongshore water mass of Lake Michigan is a significant factor in the production of algae. Nuisances which can develop with increases in algal populations include a reduction in transparency, reduction in length of filter runs at water plants, possible taste and odor problems in drinking water, interference with swimming, and deposition of filamentous algae on beaches.

Departing a moment from the text, the presentation made by the commercial fisherman on the number of pounds of alewives that they could harvest from the lake to represent a means of harvesting a substantial portion of the amount of phosphates in the lake. I am not arguing that we shouldn't stop the discharge of phosphates into the lake, but another benefit that would be derived would be that you would remove and harvest phosphates that are already present in the lake.

CHAPTER V
PART 2

INVESTIGATION OF NUISANCE ALGAE CONDITIONS ALONG LAKE MICHIGAN SHORELINE

In early August of 1966 the Water Resources Commission received complaints indicating that several Lake Michigan beaches around Muskegon and Grand Haven had unusually high concentrations of algae in the inshore waters. The subsequent Water Resources Commission survey, and it is shown in detail in Appendix K, showed that approximately 32 miles of Lake Michigan shoreline had nuisance accumulations of _Spirogyra_ and _Cladophora_ in August of 1966. This problem was first observed 6.5 miles south of Muskegon at Norton Township Park and extended intermittently to Benona, 25 miles north of Muskegon. At some beaches in this area the accumulations were not sufficient to cause nuisance conditions.

Sixty miles of shoreline from South Haven to Pentwater (excluding the area described in the above paragraph) had noticeable accumulations of Cladophora but little or no Spirogyra. In most areas the Cladophora was lying on the bottom in windrows and was not as objectionable as was the Spirogyra in suspension. Personnel in charge of these beaches voiced only moderate complaints concerning the necessity to rake up the algae once a week or so. In the area where Spirogyra was a problem, park managers received complaints of green-stained bathing suits and conditions unfit for swimming. The presence of Spirogyra could not be traced to the tributaries since it was not found in any of the river samples.

Based on algal species composition of the 8 areas studied, Holland and Manistee could be described as being the least indicative of enrichment. Populations found at Benona, Muskegon and St. Joseph were the most indicative of enrichment. There were striking differences in the quantity and quality in the insore phytoplankton and that found beyond 600 feet. Benona is the best example of this where the inshore plankton was dominated by eutrophic species of oligotrophic waters. This suggests that during the summer of 1966 the water masses inshore and offshore from 600 feet out remained separate for long enough periods to support radically different algal populations.

On the basis of this short-term survey there is an apparent relationship between the areas in which nuisance algae occur along the Michigan coastline of Lake Michigan and the proximity of sources of plant nutrients contributed via major tributaries draining urban and agricultural areas. Assuming future weather and current patterns similar to those experienced in 1966, coupled with continued contributions of present water quality from tributary streams and the existing water quality of Lake Michigan we may expect reoccurrences of nuisance algae conditions.

CHAPTER V
PART 3

BACTERIOLOGICAL MONITORING OF WATERS ALONG LAKE MICHIGAN SHORELINE

The Michigan Water Resources Commission maintains an annual summer sampling program of

Michigan's Great Lakes coastline surface waters. Bacteriological data presented in Appendix L were obtained in 1966 and 1967. Only the minimum, maximum, and geometric mean values for each sampling location are expressed in this report (Appendix L, Table 1, Figure 1) however results for all samples collected and referred to are on file in the Lansing office of the Water Resources Commission.

Of the 47 locations in the Lower Peninsula for which there is 1966 and 1967 data available, 36 had geometric mean values over 1,000 organisms per 100 ml in 1967, while in 1966 there were only 4 such locations (Appendix L, Figure 1). In 1967 the total number of sampling locations in the Lower Peninsula was expanded to 69 and of these 49 had geometric mean values over 1,000 organisms per 100 ml.

The 1967 data when examined in detail reveals a definite rise to peak coliform concentrations and then a decline for each location during the sampling period of June through August. In the extreme southern Lower Peninsula locations, the peak concentrations occurred in the latter half of June whereas in the northern portion of the Lower Peninsula they appeared in early August. Peak concentrations for locations between these 2 areas followed a gradual time progression from south to north within these limits.

Studies have shown that dead and decaying alewives contribute coliform organisms to the surrounding waters and apparently provide a suitable nutrient enriched environment for bacterial growth and propagation. The bacteriological peaks coincide with the time of appearance of large concentrations of dead alewives. The highest alewife concentrations occurred in the area from St. Joseph to Frankfort (Appendix L, Map 1).

The few sampling locations which did not follow this pattern are located in the northern portion of the Lower Peninsula above Frankfort where lower concentrations of dead alewives were observed and where industrial waste discharges from fruit canning operations contribute coliform to surface waters in the Traverse City area.

From this information, a correlation appears to exist between the high total coliform concentrations and the elevated alewife mortality of 1967. Therefore, until the alewife situation is corrected the assessment of the safety of these waters for full body contact requires the utilization of the sanitary survey and data other than that obtained during the alewife die-off. All of the public beaches in Michigan along the Lake Michigan shoreline are considered to be of satisfactory sanitary quality for full body contact.

Data from the Upper Peninsula's portion of Lake Michigan coastline is limited at this time. However, a tabulation of the available data has been included in Appendix L, Table 2.

The next few sections will relate to waste surveys and studies that have been made in Lake Michigan where large discharges of industrial waste are being made to these waters.

CHAPTER V
PART 4

BIOLOGICAL AND WATER QUALITY INVESTIGATIONS IN THE VICINITY OF THE E. I. DU PONT DISCHARGE TO LAKE MICHIGAN NEAR MONTAGUE

Four investigations of water quality and aquatic fauna have been conducted since 1957 in the immediate vicinity of the E. I. DuPont submarine discharge to Lake Michigan at Montague. The most recent investigation took place in September 1967 (Appendix M).

The studies of the bottom animals have not demonstrated any apparent injury even in the immediate vicinity of the outfall. Scuds and midges have been the dominant animals. Minnows and alewives have been observed swimming normally in the discharge as it bubbles to the surface. The bottom material is fine, clean sand with no deposit.

Water samples taken directly over the discharge in September 1967 contained 0.65 mg/l ammonia. No ammonia was detected 100 feet in any direction from the discharge. Other water quality parameters showed little variation at all sampling locations.

CHAPTER V
PART 5
RECONNAISSANCE SURVEY IN THE VICINITY OF THE DOW CHEMICAL COMPANY BRINE DISCHARGE TO LAKE MICHIGAN NEAR LUDINGTON

On August 10, 1967, a reconnaissance survey of the water quality and benthic macroinvertebrate populations was conducted in Lake Michigan in the vicinity of the Dow Chemical Company discharge near Big Sable Point (Appendix N).

The discharge containing waste brines moved north with the alongshore current in the valley between the third and fourth sand bars. Conductivity remained very high, 40,000 micromhos, as far as 1/2 mile northeast. At this point the brine mass commenced to become significantly diluted and lost its identity, although traces could be detected 2 1/2 miles distant.

Several bottom samples were visually examined in the field to judge roughly if the brine mass was grossly affecting the benthic fauna. Five samples were analyzed in the laboratory. Conclusions were that the benthic fauna in the immediate vicinity of the discharge was virtually eliminated, but that the effect was local. Populations commenced recovering 100 feet from the discharge and returned to near normal within 200 yards, depending on direction from discharge point.

Rough water prevented detailed sampling

at this time. Further investigations are scheduled to more clearly identify the affected area.

CHAPTER V
PART 6

BIOLOGICAL INVESTIGATIONS IN THE VICINITY OF THE PACKAGING CORPORATION OF AMERICA'S DISCHARGE TO LAKE MICHIGAN NEAR MANISTEE

Macroinvertebrate surveys of the Lake Michigan bottom in the vicinity of Packaging Corporation of America (PCA) discharge have been made in 1957 before the operation started, in 1958, and in 1962. The bottom animal populations in the vicinity of the discharge were indicative of a clean water environment. However, the effluent tended to "float" to the lake surface and complaints of undesirable odors and unnatural colors increased. In 1966 PCA added brine from the discharge of a nearby chemical company to their effluent. Effectively preventing the undesirable "floating."

Investigation in 1967 (Appendix O) revealed chloride concentration on the lake bottom at the discharge was 248 mg/l. The effluent was apparently flowing offshore at this time as concentrations of 130 mg/l were found 4,000 and 8,000 feet west northwest. Alongshore parallel to the discharge concentrations were generally less than 20 mg/l.

No objectionable bottom deposits could be found in the vicinity of the PCA discharge during any of the surveys. The bottom animal populations sampled a mile north and south of the discharge were typical of a clean water environment. Species diversity of the bottom fauna community was lower in the discharge zone, 3.5 species/square foot, than in the zones to the north and south, 6 species/square foot.

CHAPTER V
PART 7

AQUATIC BIOTA INVESTIGATIONS IN THE VICINITY OF THE BIG ROCK POINT NUCLEAR REACTOR

Beginning in 1960, collections (usually biannual) of aquatic plants and animals have been made in the vicinity of the Big Rock Point Reactor for radiological analysis. Background radiation levels (gross beta) were established prior to September 1962 when the Big Rock Point Reactor went critical.

Plankton, filamentous algae, periphyton, crayfish, and minnows have been collected from the Lake Michigan shore zone in the vicinity of the cooling water discharge and at 2 control stations, one three miles east and the other three miles west of the reactor. The radioactivity of plankton has not varied between these stations on a given date. The seasonal and annual changes noted are apparently related to fallout and natural background.

However, since going critical, radioactivity counts of other biota collected in the Big Rock Point vicinity have been generally higher than at the 2 control stations. During this period background radiation levels throughout the state have been decreasing. Although levels in the Big Rock Point biota are higher than the biota controls, they are similar in magnitude to the levels found before criticality (Appendix P).

CHAPTER V
PART 8
OTHER TRIBUTARY AND LAKE MICHIGAN MONITORING PROGRAMS

Water quality monitoring of Great Lakes

tributary streams was initiated by the Water Resources Commission in May of 1955 to obtain background radioactivity information. In 1963, the program was expanded to include a variety of water quality data. The specific objectives of this program were to determine long-term trends in the chemical, physical and bacteriological characteristics of tributary streams to the Great Lakes in Michigan's Lower Peninsula.

Initially 1 sampling station was established on each of 28 drainage basins in the Lower Peninsula, 12 of which are located on tributaries discharging to Lake Michigan. This provided coverage of all the major basins as well as those known to be receiving significant discharges of industrial or domestic wastes. The 12 tributary basins contain approximately 63 percent of Michigan's total land area in the Michigan basin and discharge approximately 60 percent of the total flow contributed to Lake Michigan from Michigan tributaries. Approximately 87 percent of the total population in the Michigan portion of the Lake Michigan Basin reside in the monitored basins.

The monitoring stations (Appendix Q,

Table 1) are located as close as possible to the mouths of the basins and, with 1 exception, below all known sources of waste. The exception is the station on the Kalamazoo River near Saugatuck where the effluent from the Saugatuck sewage treatment plant discharges downstream from the sampling point. In this instance, the volume of effluent is small in relation to volume of river flow and sampling below the outfall was not justified due to difficulty of collection.

Samples are collected every 2 weeks and analyzed by the Commission's laboratory in Lansing. The collection, storage, preservation and analyses of all samples are in accordance with methods and procedures prescribed by Standard Methods for the Examination of Water and Wastewater, Twelfth Edition.

A summary of data collected for this program in 1965 and 1966 is presented in Tables 2, 3 and Figure 1 of Appendix Q. The monitored tributaries and their drainage areas are shown on Map 1. In addition, the data from individual stations for selected parameters has been graphically presented in Figures 2 through 13 for the years 1965 and 1966, illustrating any seasonal or short-term fluctuations in water quality.

In addition to the regular monitoring of Lake Michigan tributaries, the Commission staff has inaugurated a program of sampling of raw water from Lake Michigan. This is done at various water treatment plants around the perimeter of the lake. The intent of the program is to establish existing water quality at the various intakes and indicate any trends which occur in the quality.

The samples are collected prior to any treatment by the plants and are handled in the manner described for tributary samples. These samples are currently collected annually. The first series was collected in 1967 and the results are shown in Table 4 of Appendix Q. Sampling locations are outlined on Map 2.

In addition to the program conducted by the Water Resources Commission the Michigan Department of Public Health requires that each water treatment plant submit monthly operating reports which contain results of physical, chemical and bacteriological tests which are made on the raw water supply. Data submitted in 1966 is summarized in Table 5 of Appendix O. The 2 programs supplement each other and furnish fairly complete documentation of water quality at water intakes in Lake Michigan.

The staff of the Water Resources Commission conducts various surveys throughout the state in accordance with its programs of pollution prevention and abatement. Table 6, Appendix Q, contains data from several such surveys which were conducted in the Lake Michigan Basin. The stations shown on Map 3 are ones which were located closest to Lake Michigan (most downstream) and are indicative of tributary water quality at the time of the surveys. This information is presented to cover areas of the basin not included under long-range monitoring. Samples in some cases were collected over 24-hour periods while others were single grab samples.

Routine sampling of the State surface waters for obtaining background radioactivity data was initiated in 1955 with the establishment of 4 sampling stations on 2 eastern Michigan streams. In 1956 the number of stations was increased to 11, of which 8 were on 5 different streams and 3 were at municipal water supply intakes on the Great lakes.

In 1958 the number of sampling stations was increased to 26, in 1960 the sampling network was expanded to 31 stations and in 1963 to 38. These include 13 stations on Great Lakes waters and 25 on interior rivers or streams. Twelve stations are at municipal water supply intakes. Map 4, Appendix Q, locates the sampling stations.

The data obtained by this program is published yearly as part of the report, "State of Michigan, Water Quality Monitoring Program, Water Quality Records", and is available in the files of the Water Resources Commission.

Five water quality parameters were selected as being indicative of the chemical water quality of the Lake Michigan tributaries; dissolved oxygen, biochemical oxygen demand, chlorides, phosphates, and nitrate nitrogen. Table 2, Appendix Q, is a summary of these 5 parameters by river basin.

Dissolved Oxygen

The 2-year average of the DO values for the monitored streams ranges from 8.6 mg/l to

11.4 mg/l. The lowest recorded single value was 6.0 mg/l which was found in the Pine River at Charlevoix and the Kalamazoo River at Saugatuck. The Kalamazoo exhibits the lowest 2-year average while the Pine and the St. Joseph rivers exhibit the highest 2-year averages.

The individual Figures 2-13, Appendix Q, illustrate the seasonal variations which occur in the DO levels, with the higher values present in the winter months and the lower values found in late summer and early fall.

Biochemical Oxygen Demand

The 2-year averages of BOD values range from a low of 1.7 mg/l in the Manistee River to a high of 5.5 mg/l in the Grand River. Only 3 of the rivers, the St. Joseph, the Grand, and the Kalamazoo have BOD's above 3.0 mg/l.

The individual graphs illustrate fairly steady BOD values throughout the 2-year period with little indication of seasonal or other trends.

Chlorides

The 2-year averages of chloride values

range from a low of 3 mg/l in the Boardman River at Traverse City to a high of 71 mg/l in the Manistee River at Manistee. Three rivers have values below 10 mg/l as an average.

The individual graphs indicate no particular trend through the 2-year period.

Phosphates - PO_4

The 2-year averages of phosphate values range from a low of 0.008 mg/l in the Manistee River to a high of 0.57 mg/l in the Black River at South Haven. In general the higher values are found in the southern part of the state which is the most densely populated with the exception of the Boardman River at Traverse City which exhibits a high value.

The individual graphs indicate a seasonal trend in phosphate values with the high readings occurring in the winter months.

To find the total amount of phosphorus (P) being contributed to Lake Michigan from Michigan tributaries, calculations were made using drainage area and flow data from U. S. Geological Survey records and PO_4 data from the tributary monitoring program. From the calculations (Appendix R), the estimated annual average amount of total phosphorus (P) discharged is 2,700,000 pounds per 1,350 tons.

Nitrate Nitrogen NO_3-N

The 2-year averages of nitrogen values range from a low of 0.188 mg/l in the White River to a high of 1.029mg/l in the Grand River. The highest values are again found in the southern part of the state.

The individual graphs indicate a seasonal fluctuation in nitrogen values with high readings in the winter months and low readings during the summer.

CHAPTER V
PART 9

VESSEL POLLUTION - OIL AND RUBBISH

The number of incidents of oil pollution from vessels engaged in commercial navigation reported to the Water Resources Commission has increased markedly in recent years. These incidents have ranged from the most serious--a sinking of an oil barge on the Lake Michigan coast, and the subsequent massive fouling of stretches of beaches for over 200 miles; to the nearly continuous summertime complaints of swimmers smeared by heavy fuel oils.

The increasing number of complaints has, in general, corresponded with the increase of vessels on the Great Lakes using oil as fuel. These have been vessels solely engaged in lake commerce as well as the growing number of vessels engaged in ocean commerce. Nearly all vessels inbound into the Great Lakes via the St. Lawrence Seaway use oil as fuel.

An attendant problem associated with Great Lakes commercial navigation is the indiscriminate overboard disposal of garbage, dunnage, and trash. The effects of this problem grow increasingly worse with the use of plastics and other non-destructible containers. There is an increasing public and private cost in the removal of this debris from Great Lakes beaches. The aesthetic damage is even more serious.

CHAPTER VI

CONCLUSIONS

The citizens and government of Michigan

are very keenly aware of the value of clean water, both in Lake Michigan and in inland lakes and streams. The people have supported, and State government has developed, broad-scale and fast moving programs of pollution control.

Michigan law provides a full and effective statutory basis for preventing and controlling pollution. The State Legislature has repeatedly shown its willingness to enact additional laws as the need for them emerges.

Through its Water Resources Commission, its Department of Public Health and its Geological Survey, Michigan has an aggressive, effective and large-scale program of water pollution control in active operation. The Michigan plan for effectuating this program in 1967-68 has been fully approved by the Secretary of the Interior.

The State has an ongoing and appropriately expanding program of waste disposal surveillance and water quality monitoring which is fully responsive to the needs for detecting and identifying its pollution problems.

The Water Resources Commission and Department of Public Health have amply demonstrated that when pollution problems are identified they can and do take proper corrective action.

The State Legislature has responded generously to Executive requests for successive increases in State expenditures for pollution control.

The Water Resources Commission has adopted water quality standards for all waters together with a plan for implementation and enforcement of the interstate waters within a time period that is fully consistent with the objectives set forth in the Federal report, "Water Pollution Problems of Lake Michigan and Tributaries".

The Michigan agencies recognize the pollution problems on waters tributary to Lake Michigan and have in operation aggressive programs for their full and timely correction. The present deficiencies in waste treatment at inland locations do not contribute to pollutional conditions in Lake Michigan except as a residual phosphate loading carries on down to the lake.

The Water Resources Commission recognizes the phosphate problem in accelerating stream and lake water enrichment, and has adopted a statewide policy and comprehensive program for phosphate removal from waste discharges, with scheduled early completion dates.

The recently accelerating algae problem in Lake Michigan along its Michigan shore appears to derive significantly from phosphate concentrations in alewives and its deposition in nearshore waters from the decomposition of these fish following their increasingly massive seasonal die-off. The control of alewife populations appears to be an essential element of algae control.

Oxygen deficiency problems in the Michigan waters of Lake Michigan are not disclosed by data collected by the Michigan Water Resources Commission. The absence of such problems is substantiated by findings of the U. S. Department of Health, Education, and Welfare Public Health Service studies under the Great Lakes-Illinois River Basin Project.

These findings, which were cited by Special Master Albert E. Maris in his report to the U. S. Supreme Court on the Chicago diversion litigation among the lake states, further show no open-lake pollutional concentrations of ammonia nitrogen, nitrate nitrogen, phosphates, ABS, toxic metals, or other physical parameters.

No Lake Michigan bathing beaches in Michigan have been closed or considered for closing due to water pollution. Bacteria counts at all such beaches, attributable to human sewage, are well within the limits recommended in the Federal report for this conference.

The discharge of sewage, garbage, trash and oils from interstate carriers, and the loss of oils and other pollutional cargo from such carriers resulting from shipwrecks, are of deep concern to the people and government of Michigan because of their serious injury and threat of injury to recreational water use. Early and full answers are needed as to where the responsibility lies for coping with this problem, as is the establishment of procedures for effective enforcement and for the prompt effectuation of emergency measures to prevent and control accidental pollutional losses from such carriers.

The implementation of Michigan's plan

and achievement of the improvements in water quality in Lake Michigan will be greatly enhanced by the earliest possible approval of the Michigan standards by the Secretary of the Interior.

Accomplishment of the Michigan pollution control program is dependent largely upon the availability of funds to build the necessary municipal waste treatment facilities. Full funding of the Federal grants authorized for this purpose in the Clean Waters Restoration Act of 1966 is urgently necessary. A massive state bonding proposal providing for full state partnership in financing has been recommended by Governor Romney to the 1968 Legislature.

In addition to the information that I have presented in this report, along with the appendices, I would like to mention some information on water filtration facilities.

We have some eight water treatment facilities on Lake Michigan. Six of the eight discharge their filter backwash to Lake Michigan without treatment. The two most recently built plants, one is by far the largest of all of those on the Lake in the Michigan section, have provided settling facilities to remove these solids before the discharge of the backwash water to Lake Michigan.

In addition to that, a new water treatment plant at New Buffalo is being required to build facilities to hold the solids from filter backwash as a part of the initial plant construction.

Earlier in this conference, information was presented that indicated dissolved oxygen deficiency in the St. Joseph River and the Menominee River.

Mr. Courchaine, do you have this information to present to the Conferees?

As a part of the surveillance program established in our plan of implementation which was submitted in June, we immediately started on our surveillance activities. We are presenting data collected as a part of this activity in July of 1967. The one report deals with the interstate water quality monitoring, Section 1, Lower Portion of Menominee River Basin, Chemical and Physical Measurements on Grab Samples Sampled on July 24-25, 1967. You will note that these samples were obtained throughout the day so that it represents both night and day conditions.

(Which said report is as follows:)

Interstate Water Quality Monitoring
Section I
Lower Portion of Menominee River Basin
Chemical and Physical Measurements on Grab Samples
Sampled on July 24-25, 1967

Sampling Location	Date	Time	Temp. °C	D.O. mg/l
Menominee River, 1st Street Bridge in Menominee	7/24	2340	24	6.2
	7/25	0215	25	6.4
	7/25	0600	22	6.4
	7/25	0943	23	5.6
	7/25	1320	24	6.1
	7/25	1710	25	6.0
	7/25	1947	26	6.4
		Average	24.1	6.2
Menominee River, U.S. 41 Bridge in Menominee	7/24	2400	24	7.0
	7/25	0224	24	6.2
	7/25	0605	23	6.6
	7/25	1005	24	2.8
	7/25	1330	24	6.8
	7/25	1720	25	6.4
	7/25	1955	26	7.4
		Average	24.3	6.2
Menominee River, Dam above M-180 Bridge, in Menominee	7/25	0010	24	5.4
	7/25	0232	23	4.8
	7/25	0620	23	5.0
	7/25	1025	24	3.0
	7/25	1415	24	5.0
	7/25	1735	25	7.2
	7/25	2002	25	6.6
		Average	24	5.3
Menominee River, Wallace & McAllister Bridge	7/25	0045	23	7.2
	7/25	0300	23	7.0
	7/25	0715	23	6.4
	7/25	1055	24	6.0
	7/25	1450	24	7.4
	7/25	1800	25	7.8
	7/25	2030	25	7.4
		Average	23.9	7.0
Little Cedar River, Co. Rd. Bridge just west of Ingalls	7/25	0105	22	7.2
	7/25	0315	22	7.2
	7/25	0735	21	5.8
	7/25	1113	24	6.2
	7/25	1500	25	8.0
	7/25	1815	26	10.4
	7/25	2042	27	9.6
		Average	23.9	7.8

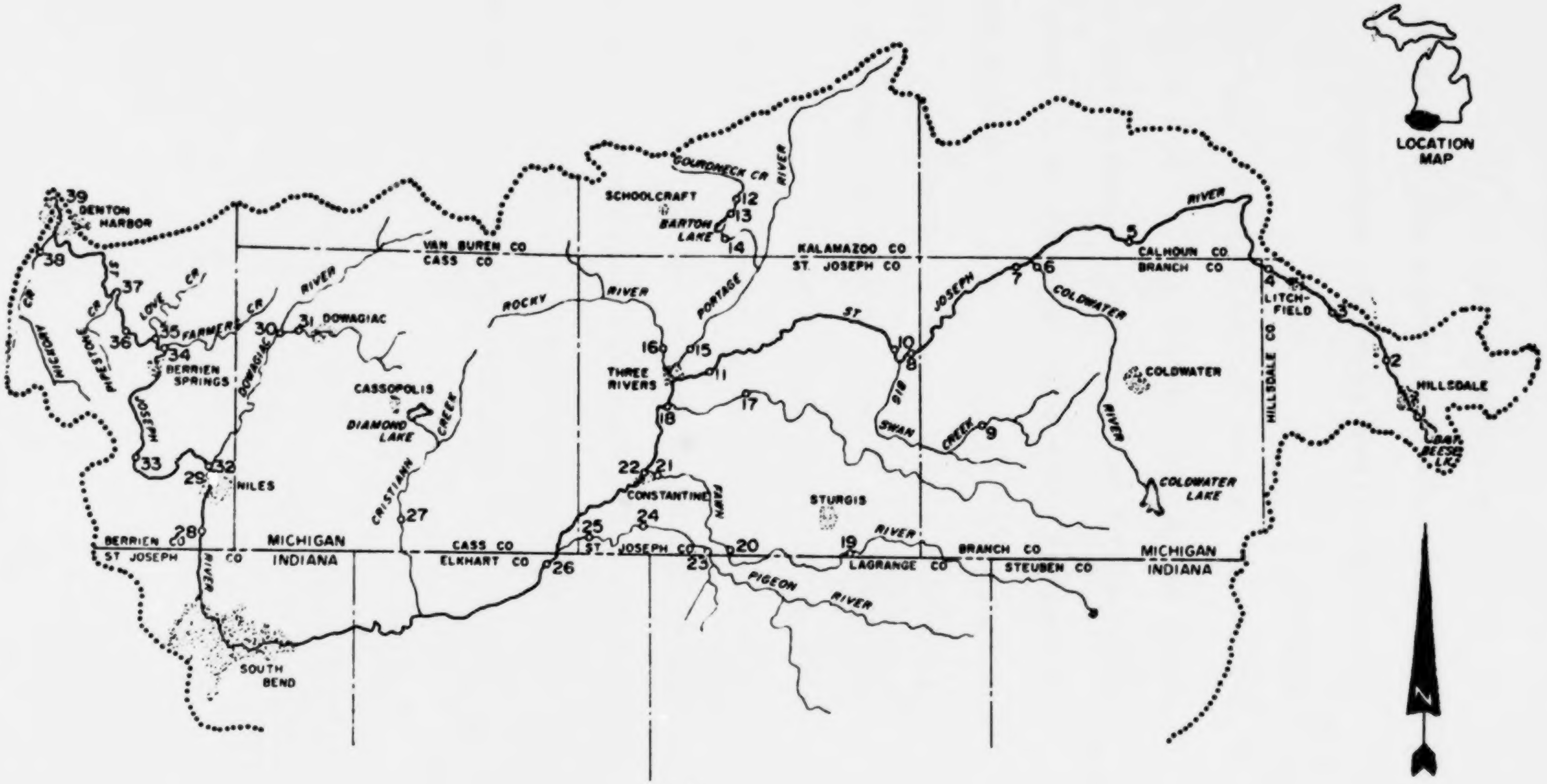
Sampling Location	Date	Time	Temp. °C	D.O. mg/l
Menominee River, Co. Rd. Bridge S.E. of Koss	7/25	0120	22	6.8
	7/25	0330	23	6.8
	7/25	0750	22	6.6
	7/25	1148	23	5.8
	7/25	1510	25	7.0
	7/25	1830	25	7.4
	7/25	2052	25	7.0
		Average	23.6	6.8
Menominee River, Chalk Hill Bridge five miles west of Banat	7/25	0200	23	6.6
	7/25	0400	22	6.8
	7/25	0820	23	6.6
	7/25	1221	24	5.9
	7/25	1535	24	6.8
	7/25	1900	24	6.6
	7/25	2115	24	7.0
		Average	23.4	6.6
Menominee River, Co. Road 374 Bridge four miles west of Nathan	7/25	0230	22	7.0
	7/25	0420	23	7.4
	7/25	0845	23	7.0
	7/25	1240	23	6.8
	7/25	1555	24	7.6
	7/25	1940	24	7.9
	7/25	2130	25	7.4
		Average	23.4	7.3
Menominee River, Railroad Bridge 1.5 miles S.W. of Faithorn	7/25	0305	21	6.2
	7/25	0445	22	6.0
	7/25	0920	22	6.4
	7/25	1307	24	6.6
	7/25	1620	24	6.8
	7/25	2010	24	7.0
	7/25	2200	23.5	6.8
		Average	22.9	6.5
Sturgeon River, U.S. 2 Bridge 3/4 mile west of Loretto	7/25	0330	20	6.8
	7/25	0510	22	7.0
	7/25	0950	21	8.4
	7/25	1342	24	7.8
	7/25	1635	25	7.6
	7/25	2110	24	7.2
	7/25	2219	24	7.0
		Average	22.9	7.4
White Creek, Co. Road 1st Bridge above mouth, two miles south of Norway	7/25	0345	12	7.2
	7/25	0520	14	7.4
	7/25	1000	13	8.4
	7/25	1430	18	7.2
	7/25	1645	19	6.2
	7/25	2205	16	6.4
	7/25	2232	16	6.0
		Average	15.4	7.0

Sampling Location	Date	Time	Temp. °C	D.O. mg/l
Menominee River, U.S. 8 Bridge S. or Norway	7/25	0355	22	7.2
	7/25	0530	20	7.2
	7/25	1015	22	7.4
	7/25	1405	24	7.0
	7/25	1655	23	7.4
	7/25	2225	23	7.2
	7/25	2241	23	7.4
		Average	22.4	7.3
Menominee River, U. S. 41 Bridge S.E. of Iron Mountain	7/25	0410	22	6.8
	7/25	0545	22	6.6
	7/25	1035	22	6.4
	7/25	1450	24	6.9
	7/25	1705	23	6.8
	7/25	2245	22	6.0
	7/25	2255	23	6.8
		Average	22.6	6.6
Menominee River, M-95 Bridge S. of Kingsford	7/25	0450	21	6.8
	7/25	0600	21	6.6
	7/25	1100	23	7.0
	7/25	1505	24	6.8
	7/25	1725	23	7.4
	7/25	2205	21	7.2
	7/25	2210	23	7.2
		Average	22.3	7.0

Interstate Water Quality Monitoring
Section II
Upper Portion of Menominee River and the Brule River Basins
Chemical and Physical Measurements on Grab Samples
Sampled on July 26, 1967

Sampling Location	Date	Time	Temp. °C	D.O. mg/l
Menominee River, U.S. 2 Bridge N. of Iron Mountain	7/26	0925	22	7.0
	7/26	1335	22.5	7.2
	7/26	1940	23	7.4
		Average	22.5	7.2
Paint River, U.S. 141 Bridge N. of Crystal Falls	7/26	0050	21	8.0
	7/26	0200	22	8.0
	7/26	0750	19	7.1
	7/26	1126	20	6.6
	7/26	1445	23	7.2
	7/26	1615	23.5	8.0
		Average	21.4	7.5
Brule River, End of Wise Co. Road at U.S.G.S. Gage	7/26	0905	19	8.3
	7/26	1313	20.5	9.8
	7/26	1945	23	9.6
		Average	21.4	9.2
Brule River, U.S. 2 and 141 Bridge, S. of Crystal Falls	7/26	0845	18	7.7
	7/26	1255	20	10.4
	7/26	1920	23	10.0
		Average	20.3	9.4
Brule River, Co. Rd. Bridge W. of Pentoga	7/26	0010	19	7.6
	7/26	0345	18	7.4
	7/26	0705	17	7.1
	7/26	1050	17.5	8.6
	7/26	1650	22	10.0
	7/26	1800	23	10.4
		Average	19.4	8.5
Brule River, Co. Rd. Bridge just below mouth of Iron River	7/26	2340	18	7.4
	7/26	0320	18	7.6
	7/26	0645	17	7.4
	7/26	1021	17	8.2
	7/26	1630	22	8.6
	7/26	1735	22	9.0
		Average	19	8.0
Brule River, M-189 Bridge	7/26	2315	19	7.4
	7/26	0250	19	7.6
	7/26	0615	16	7.8
	7/26	0943	17	8.2
	7/26	1545	23	8.6
	7/26	1715	24	8.8
		Average	19.7	8.1

Sampling Location	Date	Time	Temp. °C	D.O. mg/l
Iron River, Co. Rd. #137	7/26	2250	19	7.4
	7/26	0230	19	7.4
	7/26	0550	19	6.9
	7/26	0924	15	7.0
	7/26	1520	20	8.2
	7/26	1635	21	9.0
		Average	18.8	7.7


LOCATION MAP
N
BAW BEESE LK.
HILLSDALE
LITCH-FIELD
HILLSDALE CO
CALHOUN CO
BRANCH CO
KALAMAZOO CO
ST. JOSEPH CO
VAN BUREN CO
CASS CO
BERRIEN CO
ST. JOSEPH CO
ELKHART CO
LAGRANGE CO
STEUBEN CO
MICHIGAN
INDIANA
COLDWATER
COLDWATER LAKE
COLDWATER RIVER
ST JOSEPH RIVER
BIG SWAN CREEK
STURGIS
FAWN RIVER
PIGEON RIVER
CONSTANTINE
THREE RIVERS
PORTAGE RIVER
ROCKY RIVER
SCHOOLCRAFT
GOURDNECK CR
BARTON LAKE
CASSOPOLIS
DIAMOND LAKE
CRISTIANN CREEK
DOWAGIAC
DOWAGIAC RIVER
FARMERS CR
LOVE CR
BERRIEN SPRINGS
NILES
SOUTH BEND
PIPESTONE CR
HICKORY CR
BENTON HARBOR
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MR. PURDY: If we look at the averages you will note that these are all above 6 milligrams per liter from the standpoint of dissolved oxygen.

If we should look at the worst condition on the Menominee River, you would note that this would be at the dam above M-180 Bridge in Menominee, where at one period it fell to 3 milligrams per liter, and the Menominee River at the U.S. 41 Bridge in Menominee, where one sample of the seven obtained showed a value of 2.8 milligrams per liter.

The second report is the Interstate Water Quality Monitoring, St. Joseph River Basin, Chemical and Physical Measurements on Grab Samples Sampled on July 17-20, 1967.

(Which said report is as follows:)

Interstate Water Quality Monitoring
St. Joseph River Basin
Chemical and Physical Measurements on Grab Samples
Sampled on July 17-20, 1967

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD_5 mg/l	pH	Remarks
St. Joseph River at Griswold St. in Hillsdale, Hillsdale Co.	7/17	0937	17	0.6	7.5	7.4	Patches of oil film. Water at this station was barely moving. The surface was covered with duckweed and other vegetation. Water had a brown color.
	7/17	1356	19.5	3.5	--	--	
	7/17	1630	21	6.2	3.4	7.4	
	7/17	2100	18	2.6	--	--	
	7/18	0140	17	0.0	10.5	7.2	
	7/18	0315	18	0.7	--	--	
	7/18	0745	19	0.0	12.3	7.2	
		Average	18.5	1.9	8.5	7.3	
St. Joseph River at Moore Rd., Hillsdale Co.	7/17	0955	17	1.6	5.7	7.6	Downstream from Hillsdale S.T.P. - Abundant attached vegetation and some sludge. Water was clear.
	7/17	1428	19	3.4	--	--	
	7/17	1640	19	4.0	2.8	7.6	
	7/17	2110	19	2.8	--	--	
	7/18	0155	18	0.0	2.4	7.5	
	7/18	0345	19	0.7	--	--	
	7/18	0800	19	0.9	3.9	7.5	
		Average	18.6	1.9	3.5	7.6	
St. Joseph River at Rainey Rd., Hillsdale Co.	7/17	1017	16.5	7.8	1.7	8.1	Downstream from Jonesville.
	7/17	1444	20.5	10.4	--	--	
	7/17	1653	22	10.6	2.0	8.4	
	7/17	2130	20	8.3	--	--	
	7/18	0210	18	6.7	1.7	8.1	
	7/18	0410	18	6.8	--	--	
	7/18	0840	18	7.1	1.7	8.0	
		Average	19.0	8.2	1.8	8.2	
St. Joseph River at Mosherville Rd., Hillsdale Co.	7/17	1037	17.5	8.6	1.9	8.2	Downstream from Litchfield. Abundant attached vegetation.
	7/17	1458	21.5	11.4	--	--	
	7/17	1708	22	11.2	1.8	8.7	
	7/17	2145	20	7.7	--	--	
	7/18	0225	19	6.5	0.9	8.2	
	7/18	0430	19	6.5	--	--	
	7/18	0855	18	7.1	1.4	8.1	
		Average	19.6	8.4	1.5	8.3	
St. Joseph River at 14 Mile Rd., Calhoun Co.	7/17	1107	18.5	8.8	1.6	8.2	Downstream from Tekonsha. Water was slightly turbid.
	7/17	1526	21.5	10.3	--	--	
	7/17	1735	21	9.8	1.4	8.3	
	7/17	2235	20	6.2	--	--	
	7/18	0315	19	5.8	1.2	8.0	
	7/18	0500	19	5.7	--	--	
	7/18	0920	19	7.0	1.3	8.1	
		Average	19.7	7.7	1.4	8.2	

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD5 mg/l	pH	Remarks
Coldwater River at Gower Rd., Branch Co.	7/17	1127	19	8.7	1.9	8.1	Abundant attached vegetation. Water was clear. Rain on the 3rd sampling run. People were observed fishing and swimming at this station.
	7/17	1544	22	10.0	--	--	
	7/17	1750	21	8.8	1.5	8.2	
	7/17	2255	19	6.6	--	--	
	7/18	0335	19	6.2	1.0	7.9	
	7/18	0520	20	6.2	--	--	
	7/18	0935	20	7.5	1.5	8.1	
		Average	20.0	7.7	1.5	8.1	
St. Joseph River at Arborgast Rd., Branch Co.	7/17	1142	19	8.0	2.0	8.1	Downstream from Union City. Water was slightly turbid. Rain on the 3rd sampling run.
	7/17	1558	21	9.4	--	--	
	7/17	1804	20	9.6	1.6	8.2	
	7/17	2305	20	8.1	--	--	
	7/18	0345	19	7.2	1.3	8.1	
	7/18	0535	19	7.0	--	--	
	7/18	0950	20	7.1	1.4	8.1	
		Average	19.7	8.1	1.6	8.1	
St. Joseph River at Stowell Rd., St. Joseph Co.	7/17	1232	21	8.2	4.2	8.2	Water slightly turbid. Green color. Rain on the 3rd sampling run.
	7/17	1640	23	9.8	--	--	
	7/17	1855	22	9.6	4.6	8.3	
	7/17	2350	21	8.4	--	--	
	7/18	0435	20	7.1	3.7	8.3	
	7/18	0630	21	6.8	--	--	
	7/18	1030	20	7.4	3.4	8.3	
		Average	21.1	8.2	4.0	8.3	
Big Swan Creek at Burr Oak Rd., Branch Co.	7/17	1211	22	10.0	3.2	8.2	Downstream from Bronson S.T.P. Water was clear and moving rapidly.
	7/17	1624	25	10.6	--	--	
	7/17	1830	22	8.6	2.1	8.2	
	7/17	2330	20	6.1	--	--	
	7/18	0415	18.5	5.9	1.8	7.9	
	7/18	0610	19	6.0	--	--	
	7/18	1015	20	8.2	1.6	8.1	
		Average	20.9	7.9	2.2	8.1	
St. Joseph River at Farrand Rd., St. Joseph Co.	7/17	1252	22.5	11.8	8.2	8.4	Downstream from outlet of Sturgeon Lake. Water was slightly turbid with a green color.
	7/17	1653	24	12.2	--	--	
	7/17	1908	23	12.0	6.8	8.5	
	7/18	0000	21	10.9	--	--	
	7/18	0445	20	8.9	4.9	8.4	
	7/18	0640	21	8.5	--	--	
	7/18	1045	21	9.6	5.0	8.4	
		Average	21.8	10.6	6.2	8.4	

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD$_5$ mg/l	pH	Remarks
St. Joseph River at Sixth St. in Three Rivers, St. Joseph Co.	7/18	1050	21	9.0	4.4	8.4	Rain stopped on 1st sampling run. Rocky, sand bottom.
	7/18	1540	21	10.0	--	--	
	7/18	1730	22.5	10.2	5.9	8.4	
	7/18	2136	23	10.0	--	--	
	7/19	0145	21	9.4	6.2	8.4	
	7/19	0350	21	9.4	--	--	
	7/19	0835	21	8.2	2.4	8.6	
		Average	21.5	9.5	4.7	8.5	
Gourdneck Creek at VW Ave. in Vicksburg, Kalamazoo Co.	7/18	0930	21	9.8	1.1	8.3	Water clear. Rain on the 2nd sampling run.
	7/18	1430	22	11.6	--	--	
		Average	21.5	10.7	1.1	8.3	
Gourdneck Creek at W Ave. in Vicksburg, Kalamazoo Co.	7/18	1630	24	5.7	20	7.6	Downstream from Simpson-Lee Paper Co. Water was very turbid with a green-gray color.
	7/18	2055	24.5	5.8	--	--	
	7/19	0055	24	5.4	14	7.7	
	7/19	0300	23	5.0	--	--	
	7/19	0805	22	5.4	12	8.1	
		Average	23.5	5.5	15.3	7.8	
Portage Creek at 22nd St., Kalamazoo Co.	7/18	0945	20	7.6	5.8	8.1	Bass & bluegill seen at this station. Heavy attached vegetation. Heavy fog on the last sampling run.
	7/18	1445	23	10.2	--	--	
	7/18	1644	23	9.5	6.5	8.2	
	7/18	2103	23.5	9.4	--	--	
	7/19	0105	21.5	8.2	>8.2	8.1	
	7/19	0307	22	8.4	--	--	
	7/19	0812	21	7.4	6.6	8.3	
		Average	22.0	8.7	>6.8	8.2	
Portage River at Fifth St. in Three Rivers, St. Joseph Co.	7/18	1020	20	6.4	1.9	8.0	Very fast current. Water was clear. Rain on the 2nd sampling run.
	7/18	1520	21	7.8	--	--	
	7/18	1711	22	7.8	1.9	8.1	
	7/18	2125	22	7.0	--	--	
	7/19	0130	21	6.6	1.4	8.0	
	7/19	0355	19	6.4	--	--	
	7/19	0840	18	7.0	1.2	8.2	
		Average	20.4	7.0	1.6	8.1	
Rocky River at W. Michigan in Three Rivers, St. Joseph Co.	7/18	1040	19	8.2	1.6	8.2	Rain on the first three sampling runs. Water was light green color.
	7/18	1530	21	8.8	--	--	
	7/18	1718	22	8.8	1.8	8.4	
	7/18	2130	21	8.4	--	--	
	7/19	0135	20	7.8	1.9	8.2	
	7/19	0400	18	8.2	--	--	
	7/19	0845	18	7.8	3.3	8.4	
		Average	19.9	8.3	2.2	8.3	

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD5 mg/l	pH	Remarks
Prairie River at Three Rivers Rd., St. Joseph Co.	7/18	1115	19	8.2	1.5	8.0	Downstream from Centreville. Rain on the 2nd sampling run.
	7/18	1555	20	9.0	--	--	
	7/18	1743	21	8.2	1.7	8.1	
	7/18	2035	21	7.4	--	--	
	7/19	0030	20	6.4	1.5	8.0	
	7/19	0340	19	6.4	--	--	
	7/19	0730	18	7.0	1.2	8.2	
		Average	19.7	7.5	1.5	8.1	
St. Joseph River at Constantine Road, St. Joseph Co.	7/18	1130	21	9.0	3.8	8.3	Downstream from Three Rivers S.T.P. Water was slightly turbid with a green color.
	7/18	1610	22	9.4	--	--	
	7/18	1758	21	9.2	3.7	8.3	
	7/18	2148	22.5	9.4	--	--	
	7/19	0155	22	8.4	4.2	8.4	
	7/19	0415	21	8.2	--	--	
	7/19	0925	20	7.2	3.0	8.5	
		Average	21.4	8.7	3.7	8.4	
Fawn River at Big Hill Rd., St. Joseph Co.	7/18	1345	20	8.4	1.6	8.2	Rain the 2nd sampling run.
	7/18	1800	21	8.6	--	--	
	7/18	1955	22.5	8.2	1.3	8.3	
	7/18	2332	21	7.0	--	--	
	7/19	0410	20	6.2	0.8	8.3	
	7/19	0620	19	6.2	--	--	
	7/19	1100	19.5	7.2	1.1	8.3	
		Average	20.4	7.4	1.2	8.3	
Fawn River at Stubey Rd., St. Joseph Co.	7/18	1330	21	8.6	5.1	8.2	Downstream from Sturgis S.T.P. Rain on the first 2 sampling runs. Water was clear.
	7/18	1745	21	7.6	--	--	
	7/18	1942	23	7.0	>7	8.1	
	7/18	2314	21	5.2	--	--	
	7/19	0350	20	6.6	3.0	8.3	
	7/19	0605	19	6.4	--	--	
	7/19	1040	19	6.8	6.6	8.3	
		Average	20.6	6.9	>5.4	8.2	
Fawn River at Three Rivers Rd., in Constantine, St. Joseph Co.	7/18	1145	22	8.2	1.1	8.0	
	7/18	1625	21	8.4	--	--	
	7/18	1814	20.5	8.2	1.2	8.1	
	7/18	2158	21	8.0	--	--	
	7/19	0205	20	7.8	0.9	8.0	
	7/19	0425	19.5	8.0	--	--	
	7/19	0935	19	8.0	2.9	8.2	
		Average	20.4	8.1	1.5	8.1	

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD_5 mg/l	pH	Remarks
St. Joseph River at Washington St. (U.S.-131) in Constantine, St. Joseph Co.	7/18	1155	20	8.8	2.8	8.3	Rain on the 2nd sampling run. Water was slightly turbid with a green color.
	7/18	1630	21	10.2	--	--	
	7/18	1821	22	10.2	4.4	8.3	
	7/18	2203	21.5	10.2	--	--	
	7/19	0215	21	10.0	3.7	8.4	
	7/19	0435	20	9.6	--	--	
	7/19	0938	21	9.2	3.6	8.6	
		Average	20.9	9.7	3.6	8.4	
White Pigeon River at Sevison Rd., St. Joseph Co.	7/18	1315	20	7.8	1.1	8.2	Rain on the 2nd sampling run.
	7/18	1735	20	7.2	--	--	
	7/18	1930	23	7.0	1.7	8.2	
	7/18	2300	21	6.4	--	--	
	7/19	0330	19	6.0	1.3	8.3	
	7/19	0550	19	5.2	--	--	
	7/19	1030	19	6.0	0.7	8.3	
		Average	20.1	6.7	1.2	8.3	
White Pigeon River at Blue School Rd., St. Joseph Co.	7/18	1250	21	5.6	3.4	7.9	Downstream from White Pigeon and the Weyerhaeuser Co. Water was very turbid with a gray-green color. Heavy vegetation. Rain on the 2nd sampling run.
	7/18	1720	21	4.8	--	--	
	7/18	1915	22	4.0	3.0	7.8	
	7/18	2246	22	4.0	--	--	
	7/19	0300	21	4.2	2.6	7.9	
	7/19	0535	20	4.2	--	--	
	7/19	1015	20	4.8	2.4	8.1	
		Average	21.0	4.5	2.9	7.9	
White Pigeon River at M-103, St. Joseph Co.	7/18	1215	21	7.6	1.2	8.1	Rain on the 2nd sampling run. Water was slightly turbid with a green color.
	7/18	1695	20	8.6	--	--	
	7/18	1848	21	8.2	1.2	8.2	
	7/18	2218	21	7.4	--	--	
	7/19	0230	20.5	6.4	1.0	8.1	
	7/19	0450	19	6.2	--	--	
	7/19	0950	19	6.2	1.2	8.3	
		Average	20.2	7.2	1.2	8.2	
St. Joseph River at Elkhart Co. Rd. 25 in Bristol, Indiana	7/18	1230	20	10.6	4.1	8.4	Rain on the 2nd sampling run. Water was slightly turbid with a green color.
	7/18	1700	20	12.2	--	--	
	7/18	1858	22	11.4	5.0	8.5	
	7/18	2227	21	9.8	--	--	
	7/19	0240	21	7.6	2.6	8.3	
	7/19	0505	19	7.0	--	--	
	7/19	1000	19	7.2	2.5	8.4	
		Average	20.3	9.4	3.6	8.4	

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD$_5$ mg/l	pH	Remarks
Christiann Creek at Redfield Rd., Cass Co.	7/19	1030	21.5	7.4	1.6	8.3	
	7/19	1715	25	9.0	2.0	8.5	
	7/20	0045	23	6.6	1.6	8.5	
	7/20	0335	22	6.6	--	--	
	7/20	0730	21	6.4	1.3	8.3	
		Average	22.5	7.2	1.6	8.4	
St. Joseph River at Bertrand Rd., Berrien Co.	7/19	1100	23	6.8	6.4	8.2	Downstream from South Bend, Indiana S.T.P. Water was slightly turbid.
	7/19	1443	24	10.2	--	--	
	7/19	1745	25	12.6	9.5	8.6	
	7/19	2115	23	11.2	--	--	
	7/20	0115	23	8.2	7.0	8.5	
	7/20	0410	21	6.8	--	--	
	7/20	0755	21	6.4	6.0	8.4	
		Average	22.9	8.9	7.2	8.4	
St. Joseph River 1/4 mile N. of Niles, just upstream from confluence with Dowagiac River, Berrien Co.	7/19	1207	22	7.8	>7.8	8.3	Just downstream from Niles S.T.P. Water was turbid with a brown color.
	7/19	1530	24	10.0	--	--	
	7/19	1835	25	11.0	10.0	8.6	
	7/19	2215	23	9.8	--	--	
	7/20	0200	22	9.6	8.2	8.6	
	7/20	0455	22	9.2	--	--	
	7/20	0815	21	8.0	7.3	8.5	
		Average	22.7	9.3	>8.5	8.5	
Dowagiac River at M-62, 2.5 miles west of Dowagiac, Cass Co.	7/19	1445	25	8.2	2.2	8.3	
	7/19	2140	20	8.0	1.7	8.4	
	7/20	0530	18	7.6	1.4	--	
	7/20	1020	18	8.0	1.4	--	
		Average	20.3	8.0	1.7	8.4	
Dowagiac Creek at M-62, 2 miles west of Dowagiac Cass Co.	7/19	1440	24	8.2	5.0	8.3	Downstream from Dowagiac S.T.P.
	7/19	2130	22	5.7	3.2	8.2	
	7/20	0525	19	4.6	3.8	8.1	
	7/20	1015	20	7.4	2.8	8.2	
		Average	21.3	6.5	3.7	8.2	
Dowagiac River at Front St. (U.S. 31-33), Berrien Co.	7/19	1125	19	8.8	1.7	8.3	
	7/19	1506	20.5	8.8	--	--	
	7/19	1815	22	9.6	2.4	8.4	
	7/19	2155	22	7.6	--	--	
	7/20	0145	20	8.0	1.9	8.3	
	7/20	0430	17	7.6	--	--	
	7/20	0840	17	7.6	1.5	8.3	
		Average	19.6	8.3	1.9	8.3	

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD5 mg/l	pH	Remarks
St. Joseph River at Bear Cave Campsite, Berrien Co.	7/19	1251	23	11.0	8.5	8.7	Downstream from Buchanan S.T.P. Slight oil film in places.
	7/18	1604	24	13.0	--	--	
	7/19	1930	24	12.8	9.5	8.8	
	7/19	2245	23	11.2	--	--	
	7/20	0230	22	9.4	7.2	8.5	
	7/20	0530	21	8.2	--	--	
	7/20	0900	21	9.0	6.3	8.6	
		Average	22.6	10.7	7.9	8.7	
Farmers Creek at Hipp Hollow Rd., Berrien Co.	7/19	1500	20	8.0	2.5	--	Downstream from Eau Claire.
	7/19	2150	19	6.0	4.6	8.2	
	7/20	0545	16	6.6	2.6	8.2	
	7/20	1040	16	7.0	4.8	8.3	
		Average	17.8	6.9	3.6	8.2	
Love Creek at Hipp Hollow Rd., Berrien Co.	7/19	1510	22	8.0	3.1	8.2	Downstream from Flamm Pickle Co.
	7/19	2200	21	8.7	3.1	8.3	
	7/20	0500	18	7.6	3.4	8.2	
	7/20	1055	18.5	6.6	3.7	8.2	
		Average	19.9	7.7	3.3	8.2	
St. Joseph River at Berrien County Sportsman Park, Berrien Co.	7/19	1312	23	13.6	10.0	8.7	Downstream from Berrien Springs S.T.P. Very turbid.
	7/19	1623	24.5	15.4	--	--	
	7/19	1940	24	15.2	10.3	8.7	
	7/19	2305	22	11.2	--	--	
	7/20	0250	21	7.8	6.8	8.5	
	7/20	0550	20	6.8	--	--	
	7/20	0920	21	9.0	7.0	8.6	
		Average	22.2	11.3	8.5	8.6	
Pipestone Creek at River Rd., Berrien Co.	7/19	1530	22.5	10.0	2.2	8.7	Downstream from Sodus Fruit Exchange
	7/19	2215	19.5	7.8	1.2	8.6	
	7/20	0612	17.5	7.8	1.2	--	
	7/20	1105	19	9.0	1.2	8.6	
		Average	19.6	8.7	1.5	8.6	
Hickory Creek at U.S. 33, Berrien County	7/19	1335	20.5	8.8	2.2	8.3	Downstream from Stevensville. Floating clumps of sludge . Fungi abundant. Water was very turbid.
	7/19	1623	23	9.8	--	--	
	7/19	2005	24	8.6	2.4	7.4	
	7/19	2325	20	6.4	--	--	
	7/20	0310	18	7.0	1.5	8.3	
	7/20	0610	17	6.8	--	--	
	7/20	0945	17	7.6	1.9	8.3	
		Average	19.9	7.9	2.0	8.1	

Sampling Location	Date	Time	Temp. °C	D.O. mg/l	BOD_5 mg/l	pH	Remarks
St. Joseph River at C & O Railroad bridge in St. Joseph, Berrien Co.	7/19	1349	23	12.4	10.3	8.5	Downstream from St. Joseph and Benton Harbor S.T.P s.
	7/19	1700	24	14.2	--	--	
	7/19	2015	24	14.2	10.6	8.8	
	7/19	2350	23	14.2	--	--	
	7/20	0320	22	14.4	9.0	8.6	
	7/20	0625	21	13.2	--	--	
	7/20	1000	22	14.4	9.1	8.6	
		Average	22.7	13.9	9.8	8.6	

MR. PURDY: Again the samples are collected throughout the day so that we have a representation of both night and day conditions. The only place where we show a serious dissolved oxygen deficiency is in the very headwaters of the St. Joseph River in Hillsdale County, -- one above Hillsdale where there is very little, if any, flow; the second location just below Hillsdale and below, the effluent from the Hillsdale sewage treatment plant, and there the average value is 1.9 and we do have some zero values.

But I believe if you will look through that data that it indicates that the remainder of the St. Joseph River in particular has quite satisfactory dissolved oxygen levels.

That completes my presentation, Mr. Stein.

MR. STEIN: Thank you, Mr. Purdy.

Do we have any comments or questions?

MR. POOLE: I have one question going way back.

MR. STEIN: Yes.

MR. POOLE: My question is back earlier in the afternoon, Ralph, where you were referring to these court orders you obtained in Michigan.

The question is, how long does it take from the time that you initiate proceedings until you get a court order, approximately?

MR. PURDY: In some instances this may be in as short a period as two months. In other cases it has extended up through two, to two and a half years.

But in general I would say that within a period of three to six months that we have obtained a court decree.

I am not suggesting --

MR. STEIN: May I make a comment on the question, on the Michigan problem?

This procedure of this court order bond, as you know, developed in Michigan during the 1920's before we had this revenue bond financing, and a city wasn't restricted by its statutory debt limit as if they had a court order. Michigan always comes up with these ingenious devices to handle something, and they love to litigate up there.

And I suspect that a lot of these suits, unless I am wrong, are kind of friendly ones.

There is really no argument.

MR. PURDY: In some instances they are really quite friendly.

I would not recommend this as a way to accomplish pollution control on an expedient basis, though, because when we do go into court we lose time.

MR. STEIN: Are there any other comments or questions?

MR. HOLMER: I have one, Mr. Chairman.

MR. STEIN: Yes.

MR. HOLMER: The section on alewife overlaps, of course, what Mr. Pierce was telling us about phosphate removal policy, which is reiterated in the conclusions you have read. I can understand from what Mr. Pierce said that where you have got a lake or a stream that you're wanting to protect against phosphorus, the policy makes pretty good sense.

If I understand what you are saying about the alewife concentration on inshore waters, as far as discharges to those waters are concerned in terms of preventing algal growth, you are suggesting that such a policy would not be useful, since there is enough phosphorus there already.

MR. PURDY: I am saying that we have to attack both problems if we are to correct the nuisance algal problems that we have on our Lake Michigan beaches. This is the bridge that our commission has crossed. We feel that we need to control the phosphate discharges from our point sources. We feel for this program to be fully effective that the alewife problem must also be solved.

The alewife does not in itself place the phosphate in the lake. It only serves to collect it from throughout the lake and reconcentrate it in our inshore waters.

MR. MITCHELL: Mr. Purdy, you stated that a massive state bonding program has been proposed by Governor Romney. Can you describe the proposal?

MR. PURDY: This proposal was described by Lieutenant Governor Milliken on the first day. It includes 285 million dollars to pay Michigan's 25 percent share in the Federal program. In addition to that, it would pre-finance the 75 percent share so that this program would not be fully dependent upon the full funding of the Federal program at this time.

Throughout the period between now and 1980 we are hopeful that the Federal Government will, at least by that time, commit as much money as is presently authorized in the Federal Bill, and this money is essential to the program throughout the full period of time.

In addition to that, 50 million dollars has been proposed to help small municipalities build collection sewers. This would not be a grant, but it would be a loan. It would also serve to place the full faith and credit of the State behind the issuance of bonds for this purpose.

MR. STEIN: Yes, Mr. Poston?

MR. POSTON: Mr. Purdy, you say that the Water Resources Commission recognizes the phosphate problem in accelerating stream and lake water enrichment and has adopted a statewide policy and comprehensive program for phosphate removal from waste discharges along with scheduled early completion dates.

Would you care to elaborate a little or

the proposals for phosphate removal and also the scheduled completion dates that your commission has in mind?

MR. PURDY: Right at the moment, we concur with Dr. Weinberger in that chemical precipitation, whether it be by the metallic ion or some other chemical as mentioned by Dr. Weinberger, should be the approach that we use immediately.

We have adopted the policy that any new or increased use of waters of the state shall incorporate phosphate removal as a part of the design of the facility, so if this facility were scheduled to go in operation a year from today, that would be the day that we would ask for phosphate removal.

In addition to this, Lake Odessa, one of the communities reported by Mr. Pierce, lying within the Lake Michigan Basin, is under an order of the Commission to have phosphate removal as a part of its treatment operations, I believe by 1970. I would have to check that in the report.

The City of Traverse City has entered into a voluntary treatment with the Commission to provide phosphate removal by 1971, if memory serves me correctly.

MR. HOLMER: Have you adopted a standard, a parameter of some kind?

MR. PURDY: We are asking the people to shoot at and attain an 80 percent removal of total phosphates at the present time. Our Commission first established this as a goal for Detroit in another enforcement matter some two years ago. At that time it was not certain that we could reach this level. However, rather than place in a maximizing phosphate removal as an objective, we felt that we should give our consulting engineers a specific goal to scramble for and they have been doing a pretty good job of scrambling. We may not reach this in all instances. We may go above it.

MR. STEIN: Are there any further questions or comments?

(No response.)

MR. STEIN: I notice that you have a pretty good DO level on the Menominee River, better than when we were up there.

MR. PURDY: Yes, sir.

MR. STEIN: That is one way to clean up pollution, for the pulp and paper mills to stop pulping operations, but I don't recommend that generally.

MR. PURDY: That particular plant was not in Michigan.

MR. STEIN: I know.

MR. MITCHELL: I was curious to know a little bit more about your State financing. If, then, your Legislature agrees with your Governor and accepts the bond issue, is it required to go before a referendum?

MR. PURDY: That will have to go before the people and be supported.

MR. MITCHELL: And what time might that come about?

MR. PURDY: Hopefully, if the legislation clears through the Legislature in this session, it could be placed before the people in November.

MR. MITCHELL: The same time that Illinois might have theirs -- will yours be put before the people?

MR. PURDY: If Illinois is scheduled

for November, it would be the same time.

MR. STEIN: Mr. Frangos.

MR. FRANGOS: With reference to the proposed rules for control of watercraft pollution, is it correct, is my reading correct, that the rules as you propose them would not preclude devices that would result in discharges to the water courses directly?

MR. PURDY: Will you restate that?

MR. FRANGOS: Well, in Section 2(b)iii--

MR. STEIN: Why don't you point to the page in his report?

MR. FRANGOS: Yes.

MR. PURDY: I have it.

MR. STEIN: What page is that, Ralph?

MR. PURDY: Page 56.

MR. STEIN: All right.

MR. PURDY: Where we could approve the discharge --

MR. FRANGOS: My question is, you do not rule out the use of devices that would in effect result in a discharge to any watercourse on which this boat may be traveling at the time?

MR. PURDY: That's correct. However,

in our public hearings we have made it very clear that at the present time we of the staff do not know of a macerator chlorinator device which we could recommend to the Commission that it would approve.

MR. STEIN: Are there any other comments?

(No response.)

MR. STEIN: This is a funny way of reading this. I don't know, I don't see your lawyers here; I guess they all went home.

MR. PURDY: We have worn out a lot of people.

MR. STEIN: Yes.

The way I read this, this may or may not permit a discharge depending upon your circumstances. It is clear one or two don't permit a discharge.

Now, unless you say that the sewage discharge is non-pollutional, then they can't get iii and there is nothing to indicate that you are going to have a discharge overboard that is going to meet that. As a matter of fact, so far you haven't.

MR. PURDY: Well, as you know, this is a very controversial issue. In the public hearings our Commission did make it very clear that at the present time the only devices that they could approve would be under items i and ii. This does not preclude that at some later date that some ingenious person may come forward with a device which could be approved.

MR. STEIN: I am not sure that that phrase that we are talking about in the Chicago Ordinance did not leave the same kind of escape hatch. But I think the question, as far as I see, is developing in the States of not approving a device at the present time as a practical matter which discharges wastes from the boats.

MR. PURDY: Yes.

MR. STEIN: Are there any other comments or questions?

(No response.)

MR. STEIN: If there are not, thank you very much for a very complete presentation.

Mr. Purdy, did you want this entire report included in the record?

MR. VOGT: Yes, sir, we do, Mr. Chairman.

MR. STEIN: Without objection, this will be entered in its entirety as if read.

(The report referred to is as follows:)

2625

REPORT

on

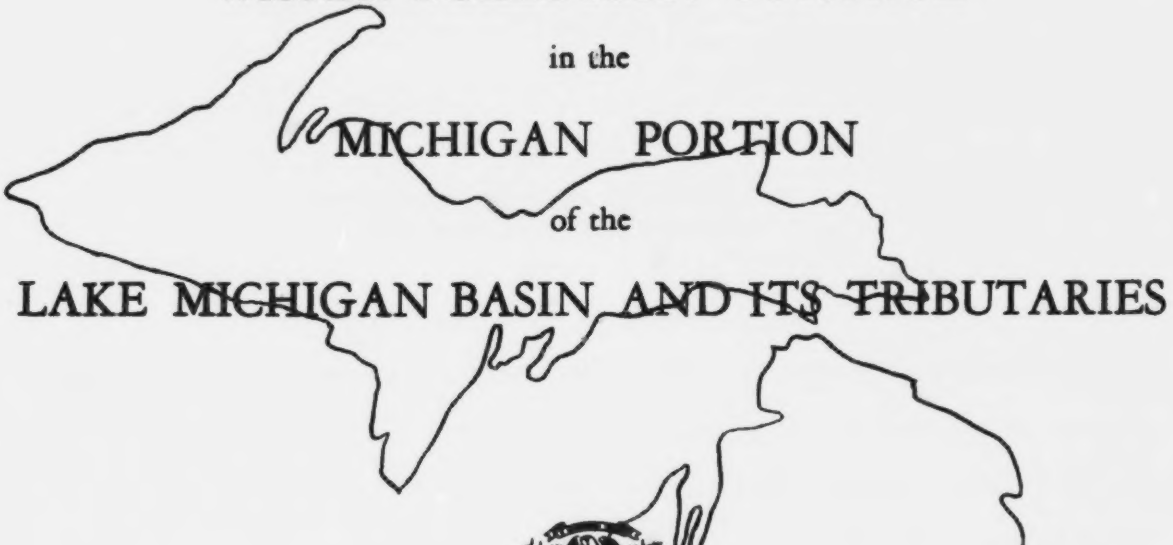
WATER POLLUTION CONTROL

in the

MICHIGAN PORTION

of the

LAKE MICHIGAN BASIN AND ITS TRIBUTARIES



Prepared and Published
by the

MICHIGAN WATER RESOURCES COMMISSION
DEPARTMENT OF CONSERVATION
and

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

State of Michigan

January 31, 1968

MICHIGAN WATER RESOURCES COMMISSION
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Report on Water Pollution Control in the Michigan Portion of the Lake Michigan Basin and its Tributaries

Prepared for Presentation on Behalf of the

Michigan Water Resources Commission

of the

Department of Conservation

and

Michigan Department of Public Health

at the

Conference Called by the

Secretary of the Interior

on

Pollution of the Waters of Lake Michigan

and

Its Tributary Basin
(Illinois-Indiana-Michigan-Wisconsin)

January 31, 1968

CONTENTS

Page

LIST OF ILLUSTRATIONS . . . v

PREFACE . . . xi

I. STATUTORY AUTHORITY . . . 1
  Michigan Law Relating to Water Pollution Control . . . 1
    A. Authority for local units of government to build, own, and operate waste treatment facilities . . . 1
    B. Authority for the control of water pollution . . . 3
  Legal History . . . 5

II. POLLUTION CONTROL PROGRAM . . . 11
  Water Resources Commission Pollution Control Program . . . 11
  Department of Public Health Pollution Control Program . . . 13
    Facilities Planning and Approval . . . 13
    Facilities Operation . . . 15
    Operator Certification and Training . . . 15
    Disinfection Policy and Practice . . . 16
  Studies on Removal of Phosphates from Waste Water at Municipal Treatment Plants . . . 16

III. DISCHARGES TO SURFACE WATERS . . . 20
  Industries . . . 20
  Governmental Units . . . 22

IV. LAKE MICHIGAN BASIN DESCRIPTION AND WATER USES . . . 23
  Basin Description . . . 23
  Water Uses . . . 27

V. 1. The Relationship Between the Lake Michigan Alewife Die-off and Resulting Water Quality . . . 32

  2. Investigation of Nuisance Algae Conditions Along Lake Michigan Shoreline . . . 34

  3. Bacteriological Monitoring of Waters Along Lake Michigan Shoreline . . . 35

  4. Biological and Water Quality Investigations in the Vicinity of the E. I. duPont Discharge to Lake Michigan at Montague . . . 36

  5. Reconnaissance Survey in the Vicinity of the Dow Chemical Company Brine Discharge to Lake Michigan near Ludington . . . 37

  6. Biological Investigations in the Vicinity of the Packaging Corporation of America's Discharge to Lake Michigan near Manistee . . . 38

7. Aquatic Biota Investigations in the Vicinity of the Big Rock Point Nuclear Reactor 39

8. Other Tributary and Lake Michigan Monitoring Programs. 40

9. Vessel Pollution - Oil and Rubbish 43

VI. CONCLUSIONS 44

APPENDIX A - Act 245, Public Acts of 1929, as amended. 47

APPENDIX B - Control of Watercraft Pollution 53

APPENDIX C - Michigan's Interstate Water Quality Standards 57

APPENDIX D - Michigan's Intrastate Water Quality Standards 63

APPENDIX E - Chlorination Policy 69

APPENDIX F - Studies on Removal of Phosphates at Grayling, Michigan. 73

APPENDIX G - Studies on Removal of Phosphates at Lake Odessa, Michigan . . . 93

APPENDIX H - Industrial Surface Water Discharges in the Lake Michigan Basin. 113

APPENDIX I - Municipal Waste Water Discharges in the Lake Michigan Basin. 131

APPENDIX J - Possible Effects of the Alewife Die-Off on Lake Michigan Water Quality. 145

APPENDIX K - Preliminary Survey of Algae Problems - Lake Michigan Beaches and Phytoplankton Survey - Michigan Inshore Waters of South-Central Lake Michigan. 163

APPENDIX L - Summary of Bacteriological Data for Lake Michigan Waters. . . . 177

APPENDIX M - Biological Surveys in the Vicinity of the E. I. duPont de Nemours and Company Discharge to Lake Michigan. 183

APPENDIX N - Reconnaissance Survey of the Dow Chemical Company Brine Discharge to Lake Michigan 199

APPENDIX O - Benthic Macroinvertebrate Study - Lake Michigan at Manistee in the Vicinity of Packaging Corporation of America's Waste Disposal Pipeline. 209

APPENDIX P - Radiological Investigations of Aquatic Biota in the Vicinity of the Big Rock Point Nuclear Reactor. 221

APPENDIX Q - Tributary Monitoring Data and Special Surveys 233

APPENDIX R - Phosphorus Input to Lake Michigan 259

LIST OF ILLUSTRATIONS

MAPS

No.	Title	Page
K-1	Areas in S.E. Lake Michigan affected by nuisance algae.	166
K-1a	Location of plankton sampling stations.	170
K-3	Plankton concentrations 75' offshore and 1 mile offshore.	173
L-1	Lake Michigan beach sampling locations.	179
M-1	Combined chemical and bottom fauna sampling stations - vicinity of duPont discharge, Montague, Michigan, September 10, 1957.	189
M-2	Combined chemical and bottom fauna sampling stations - vicinity of duPont discharge, Montague, Michigan, September 6, 1967	190
N-1	Water quality sampling locations in the vicinity of the Dow Chemical Company discharge, Big Sable Point.	206
N-2	Benthic macroinvertebrate sampling stations in the vicinity of the Dow Chemical Company discharge off Big Sable Point	207
O-1	Sampling stations in the vicinity of Packaging Corporation of America's pipeline, Manistee, Michigan	216
O-2	Sampling stations in the vicinity of Packaging Corporation of America's pipeline, Manistee, Michigan	219
P-1	Location map, Big Rock Point Nuclear Power Reactor.	225
Q-1	Basins in water quality monitoring program.	236
Q-2	Raw water intakes	252
Q-3	Special surveys	255
Q-4	Radioactivity sampling locations.	257

TABLES

No.	Title	Page
1	Direct industrial discharge to Lake Michigan.	20
2	Summary of industrial discharges in the Lake Michigan Basin	21
3	Direct municipal discharges to Lake Michigan.	22
G-1	BOD removal - Lake Odessa, Michigan	105
G-2	Sludge digestion data - Lake Odessa, Michigan	109
H-1	Direct industrial discharges to Lake Michigan	115
H-2	Industrial surface water discharges in the Lake Michigan Basin.	116
I-1	Municipal waste water discharge inventory in the Lake Michigan Basin. .	133
J-1	Lake Michigan water quality off Frankfort	153
J-2	Coliform and fecal coliform bacteria populations.	154
J-3	Water quality in tubs during decomposition of alewives.	156
J-4	Algae cell counts, experimental tubs.	159
K-1	Phytoplankton dominants from the mouths of seven tributaries and eight locations near shore in southcentral Lake Michigan	172
K-2	Algal conditions of selected Lake Michigan beaches.	174
K-3	Soluble orthophosphate concentrations as PO_4 in mg/l along the southeast-central Lake Michigan shoreline and in nearby tributaries.	175
K-4	Plankton composition from the mouths of seven tributaries and eight locations near shore in southcentral Lake Michigan	176
L-1	Summary of bacteriological data for Lake Michigan waters.	181
L-2	Upper Peninsula bacteriological data tabulation	182
M-1	Quantitative survey of benthic macroinvertebrates, vicinity of duPont discharge near Montague, September 10, 1967	191
M-2	Quantitative survey of benthic macroinvertebrates, vicinity of duPont discharge near Montague, September 6, 1967.	192
M-3	Lake Michigan surface water quality, vicinity of E. I. duPont discharge, September 10, 1957.	193

TABLES CONTINUED

No.	Title	Page
M-4	Lake Michigan surface water quality, vicinity of E. I. duPont discharge, September 6, 1967	194
M-5	Amphipods, oligochaets and midges in benthos samples from Lake Michigan	187
N-1	Water quality, Lake Michigan, in the vicinity of the Dow Chemical Company discharge, Big Sable Point	204
N-2	Benthic macroinvertebrate organisms per square foot in the vicinity of the Dow Chemical Company discharge, Big Sable Point	205
O-1	Sampling locations, chemical and benthic macroinvertebrate study, vicinity of Packaging Corporation of America's pipeline, Manistee, Michigan	212
O-2	Results of survey in the vicinity of Packaging Corporation of America's pipeline, Manistee, Michigan	217
O-3	Tabulation of chemical and physical data, vicinity of Packaging Corporation of America's pipeline, Manistee, Michigan	218
Q-1	Tributary water quality station description	235
Q-2	Summary of selected water quality parameters	238
Q-3	Coliform data - tributaries	251
Q-4	Sample results - domestic water intakes	253
Q-5	Sample results - domestic water intakes	254
Q-6	Data from special surveys	256
R-1	Flow data - tributaries	262
R-2	Phosphorus contributed to Lake Michigan	263

FIGURES

No.	Title	Page
F-1	No chemical treatment - suspended solids - Grayling, Michigan	83
F-2	No chemical treatment - BOD - Grayling, Michigan.	84
F-3	Chemical treatment - total phosphate - Grayling, Michigan	85
F-3a	T-PO_4 removal - Grayling, Michigan	86
F-4	Chemical treatment - suspended solids - Grayling, Michigan.	87
F-4a	Suspended solids removal - Grayling, Michigan	88
F-5	Chemical treatment - BOD - Grayling, Michigan	89
F-5a	BOD removal - Grayling, Michigan	90
G-1	Suspended solids removal - Lake Odessa, Michigan.	101
G-2	Suspended solids - Lake Odessa, Michigan.	102
G-3	BOD removal - Lake Odessa, Michigan	103
G-4	BOD - Lake Odessa, Michigan	106
G-5	Phosphate removal - Lake Odessa, Michigan	107
G-6	Total phosphates - Lake Odessa, Michigan.	108
J-1	Coliform and fecal coliform bacteria populations in experimental tubs	155
J-2	DO, BOD, and pH concentrations in experimental tubs with decomposing alewives	157
J-3	Ammonia, soluble orthophosphate, and total phosphate concentrations in experimental tubs containing decomposing alewives	158
J-4	Relationship between coliform bacteria, total phosphate, soluble orthophosphate and plankton algae - control tubs	160
J-5	Relationship between coliform bacteria, total phosphate, soluble orthophosphate and plankton algae - test tubs.	161
J-6	Relationships between potential total phosphate release as PO_4 from dead alewives and volume of phosphorus-free water.	162
K-2	Total phytoplankton count at each location compared to the inshore beach tow - Lake Michigan.	171

FIGURES CONTINUED

No.	Title	Page
L-1	Bacteriological data for Lake Michigan waters	180
M-3	Number of species of bottom animals per square foot and their tolerance status, duPont survey, Lake Michigan, 1957	195
M-4	Number of species of bottom animals per square foot and their tolerance status, duPont survey, Lake Michigan, 1967	196
M-5	Relationship between water depth and tolerance status of benthic fauna, E. I. duPont survey, Lake Michigan, September 1957.	197
M-6	Relationship between water depth and tolerance status of benthic fauna, E. I. duPont survey, Lake Michigan, September 1967.	198
N-3	Benthic macroinvertebrate species per square foot and their tolerance status, vicinity of Dow Chemical Company discharge, Big Sable Point.	208
O-3	Number of bottom dwelling macroinvertebrates and their tolerance status, vicinity of Packaging Corporation of America's pipeline, Manistee, Michigan	220
P-2	Annual radiological concentration averages in the vicinity of Big Rock Point Nuclear Reactor	226
P-3	Plankton radioactivity near Big Rock Point Reactor.	227
P-4	Periphyton radioactivity near Big Rock Point Reactor.	228
P-5	Filamentous algae radioactivity near Big Rock Point Reactor	229
P-6	Crayfish radioactivity near Big Rock Point Reactor.	230
P-7	Shore minnow radioactivity near Big Rock Point Reactor.	231
Q-1	Summary of selected water quality parameters - tributaries.	237
Q-2-13	Water quality of Lake Michigan tributaries, 1965 and 1966	239-250

Preface

This report contains information on the municipal and industrial waste disposal situation in the Michigan portion of the interstate waters of Lake Michigan and in the tributaries to Lake Michigan in Michigan. It delineates the statutes that provide the local units of government authority to build, own and operate waste treatment facilities. It delineates the State statutes for control of water pollution. It delineates the accomplishments that have been made in controlling pollution and the measures that are being taken to provide improved control. It also describes the uses being made of these waters and water quality conditions.

The report was prepared for presentation to the conferees at the Federal conference called by the Secretary of the Interior for their consideration and appraisal in (1) arriving at conclusions as to whether waste discharges originating from Michigan sources are endangering the health or welfare of persons in a state other than that in which the discharge or discharges originate, (2) determining the adequacy of measures that have been taken for abatement of pollution, and (3) determining the nature of delays, if any, being encountered in abating pollution.

The area encompassed by the report includes all of the Michigan portion of Lake Michigan and its tributaries.

All sources of municipal sewage and industrial waste discharges to surface waters are covered. The nature of waste treatment or control measures in effect are described and the state agency action to control pollution and evaluate accomplishments is related.

The files and records of the Michigan Water Resources Commission and Michigan Department of Public Health are the sources of information contained in the report. The employed staffs of both agencies collaborated in assembling the material and preparing the report.

CHAPTER I

STATUTORY AUTHORITY

MICHIGAN LAW RELATING TO WATER POLLUTION CONTROL

A. Authority for local units of government to build, own, and operate waste treatment facilities:

1. Act 107, Public Acts of 1941 - An act to authorize township water supply and sewage disposal systems, and the issuance of revenue bonds or notes therefor.

2. Act 116, Public Acts of 1923 - An act to authorize townships to establish and maintain garbage systems or plants for the collection and disposal of garbage or contracting therefor, constructing or acquiring and maintaining sanitary sewers and sewage disposal plants; to provide for making, levying and collecting of special assessment bonds.

3. Act 342, Public Acts of 1939 - An act to authorize counties to establish and provide connecting water, sewer and/or sewage disposal improvements and services within or between cities, villages, townships and township improvement districts including disposal facilities and services and to provide methods for obtaining money for the aforesaid purposes.

4. Act 3, Public Acts of 1895 - An act to provide for the incorporation of villages and to define their powers and duties.

5. Act 215, Public Acts of 1895 - An act to provide for the incorporation of cities of the fourth class and to define the powers and duties of such cities.

6. Act 279, Public Acts of 1909 - An act to provide for the incorporation of cities and for revising and amending their charters.

7. Act 312, Public Acts of 1929 - An act to provide for the incorporation by any two or more cities, villages or townships. or any combination or parts of same for supplying sewage disposal.

8. Act 245, Public Acts of 1947 - An act to regulate the ownership, extension, improvement and operation of public water and sewage disposal systems lying within two or more public corporations; and to provide for the payment and security of revenue bonds issued for the construction, acquisition, extension and improvement of such systems.

9. Act 82, Public Acts of 1955 - An act to provide for the acquirement by a city of the water supply system and/or sewage disposal system of a metropolitan district and to permit such a city to own, maintain, operate, improve, enlarge and extend such systems either within or without its limits.

10. Act 76, Public Acts of 1965 - An act to authorize counties, townships, villages, cities and any other governmental unit to construct waste disposal systems by agreements or contracts with governmental units or agencies of another state.

11. Act 185, Public Acts of 1957 - An act to authorize the establishment of a department and board of public works in counties; to authorize the issuance and payment of bonds; and to prescribe a procedure for special assessments and condemnation.

12. Act 233, Public Acts of 1955 - An act to provide for the incorporation of certain municipal authorities to acquire, own, extend, improve and operate sewage disposal systems and to provide for the issuance of bonds to acquire, construct, extend or improve sewage disposal systems.

13. Act 320, Public Acts of 1927 - An act to authorize legislative bodies of municipalities to issue and sell bonds necessary for the construction of sewage disposal plants whenever a court of competent jurisdiction shall have ordered same.

14. Act 373, Public Acts of 1925 - An act to authorize legislative bodies of municipalities to issue and sell bonds necessary for the construction of storm and sanitary sewers whenever a court of competent jurisdiction shall have ordered same.

15. Act 94, Public Acts of 1933 - An act to authorize public corporations to purchase, acquire, construct, improve, enlarge, extend or repair public improvements within or without their corporate limits, and to own, operate and maintain the same; to provide for the issuance of bonds and refunding bonds payable solely from the revenues of public improvements; to provide for the imposition of special assessments against properties benefited by such public improvements, and for the issuing of special assessment bonds for the purpose of refunding outstanding revenue bonds.

16. Act 278, Public Acts of 1909 - An act to provide for the incorporation of villages and for changing their boundaries; to provide for acquiring by purchase, land without its corporate limits necessary for the disposal of sewage and garbage. . .

17. Act 188, Public Acts of 1954- An act to provide for the making of certain public improvements by townships; to provide for assessing the whole or a part of the cost thereof against property benefited; and to provide for the issuance of bonds in anticipation of the collection of such special assessments, and for the obligation of the township thereon.

    Improvements which can be made under this act include construction and maintenance of sewers.

18. Act 359, Public Acts of 1947 - An act to authorize the incorporation of charter townships; to provide a municipal charter therefor; and to prescribe the powers and functions thereof including the installation of garbage disposal systems, the laying of storm and sanitary sewers and the installation of water systems.

19. Act 202, Public Acts of 1943 - An act relative to the borrowing of money by municipalities, and the issuance of bonds, notes and certificates of indebtedness; to provide for tax levies and sinking funds; to create the municipal finance commission; and to prescribe its powers and duties.

B. Authority for the control of water pollution:

1. Act 28, Public Acts of 1955 - Great Lakes Basin Compact. An act providing for cooperation of agencies of the state with the great lakes commission.

2. Act 243, Public Acts of 1959 - An act to regulate trailer coach parks; to prescribe the powers and duties of the director of the department of public health; and to provide remedies and penalties for violations.

3. Act 40, Public Acts of 1956 - An act to codify the laws relating to drains, and such structures and mechanical devices as will properly purify the flow of such drains; and to provide for the assessment and collection of taxes.

4. Act 20, Public Acts of 1964 - An act to regulate the impoundment and utilization of surplus water and to prescribe certain powers and duties of the water resources commission.

5. Act 291, Public Acts of 1965 - An act to protect riparian rights and of the public trust in navigable inland lakes and streams; to regulate the uses thereof including dredging and placing spoil on bottom lands; and to prescribe the duties and powers of the department of conservation.

6. Act 17, Public Acts of 1921 - An act to provide for the protection and conservation of the natural resources of the state and to create a department of conservation.

7. Act 247, Public Acts of 1955 - An act to authorize the department of conservation to regulate the filling in of submerged patented lands.

8. Act 245, Public Acts of 1929 - An act to create a water resources commission to protect and conserve the water resources of the state, to have control over the pollution of any waters of the state and the great lakes, with power to make rules and regulations governing the same and to provide penalties for the violation of the act.

9. Act 222, Public Acts of 1949 - An act to authorize public corporations to accept grants and other aid from the U.S. Government and from industries for the construction of pollution abatement facilities; and to authorize public corporations to enter into contracts with industries for the use of disposal facilities.

10. Act 329, Public Acts of 1966 - An act to provide state grants for sewage treatment facilities and to provide for administration of the grants by the water resources commission.

11. Act 211, Public Acts of 1956 - An act to prescribe certain powers and duties of the water resources commission in making studies and investigations in the establishment of sewage disposal districts.

12. Act 253, Public Acts of 1964 - An act to enable local units of government to cooperate in planning and carrying out a coordinated water management program in a watershed, and to prescribe certain powers and duties of the water resources commission.

13. Act 222, Public Acts of 1966 - An act to provide for the exemption of industrial water pollution control facilities from certain taxes.

14. Act 98, Public Acts of 1913 - An act providing for the supervision and control by the director of the department of public health over sewerage systems, and providing penalties for violations.

15. Act 87, Public Acts of 1965 - An act to license and regulate garbage and refuse disposal and to provide penalties for violation.

16. Act 196, Public Acts of 1963 - An act to control and prohibit the littering of public and private property and waters.

17. Act 288, Public Acts of 1967 - An act to regulate the subdivision of land; and to promote the public health by providing authority to the department of public health to approve subdivisions not served by public sewers on basis of suitability of soils.

18. Act 218, Public Acts of 1967 - An act to protect the public health by providing for the supervision and control of bathing beaches open to the public; and to prescribe the functions of health agencies.

19. Act 61, Public Acts of 1939 - An act to provide for a supervisor of wells; to provide for the prevention of waste and for the control over certain matters, persons and things relating to the conservation of oil and gas and for the making and promulgation of rules, regulations and orders relative therefor; to provide for the plugging of wells and for the entry on private property for that purpose; to provide for the enforcement of such rules, regulations and orders and of the provisions of this act and to provide penalties for the violations thereof; to prevent damage to or destruction of fresh water supplies and valuable brines by oil, gas, or other wastes; to require the disposal of salt water and brines and oily wastes produced incidental to oil and gas operations, in such a manner and by such methods and means that no unnecessary damage or danger to or destruction of surface or underground resources shall result.

20. Act 306, Public Acts of 1927 - An act to provide for county and district health departments; to prescribe their powers and duties; to provide for the apportioning of funds appropriated by the state, for aid to city, county and district health departments.

21. Act 350, Public Acts of 1865 - An act to protect fish and to preserve the fisheries by preventing the unlawful dumping into the waters of certain materials.

Legal History

Prior to 1929 authority of the State of Michigan to abate pollution rested upon a basis of common law. In 1913 the Michigan Supreme Court held in **Attorney General ex rel Township of Wyoming vs. City of Grand Rapids**, 175 Mich. 503, that the State Attorney General acting under his broad common law powers had the authority to file suits on behalf of the State of Michigan to compel the City of Grand Rapids to abate the public nuisance that it was making in the waters of the Grand River by discharging raw sewage therein. In its decree the Supreme Court ordered that the City construct such works as were necessary to abate the pollution within one year.

In 1929 the Michigan Legislature enacted the Stream Control Commission Act (Act 245, Public Acts of 1929) establishing a 5-member Commission consisting of the Director of Conservation, the State Health Commissioner, the Highway Commissioner, the Commissioner of Agriculture and the Attorney General. This Act defined unlawful pollution as the discharge to the waters of the state of *"any waste or pollution of any kind that will tend to destroy fish life or be injurious to public health"*. The law further provided the Stream Control Commission with authority to ascertain and take appropriate action where existing conditions in any lake, river, stream or other waters of the state were deemed by the Commission to be unreasonable and against public interest. In order to insure compliance with Stream Control Commission Orders, the statute provided for a formal notice, hearing and Order procedure.

The constitutionality and authority of the Stream Control Commission to issue Orders requiring the abatement of pollution of the waters of the state was reviewed in **City of Niles vs. Stream Control Commission**, 296 Mich. 650, decided March 11, 1941. In that case the City of Niles appealed from an Order of the Stream Control Commission directing the City to begin construction of a sewage treatment plant for the purpose of preventing the discharge of raw sewage into the St. Joseph River. The Supreme Court sustained the authority of the Commission, validated this Order and compelled the City of Niles to comply.

In the course of that decision the court made some notable observations, among which is the following:

> *"In order to stop pollution of the river, it was necessary for the Commission to take action against the City of Niles, inasmuch as it was the first city in the State on the course of the river below the Indiana cities and thus opened the way for suit to compel the Indiana cities to stop pollution of the waters of the river. It is an instance where the state must clean up its own dooryard before being in a position to ask or seek to compel its neighbor to clean up. This was not an arbitrary exercise of power by the Commission but a practical movement toward accomplishment of a most desirable end."* (Quoted on p. 157, 305 Mich. Rep.)

However, the most notable series of cases involved the enforcement of the Order which was issued by the Stream Control Commission against the City of Port Huron. On February 11, 1936, the Commission issued an Order against the City of Port Huron requiring it *"to proceed to the construction of a sewage treatment plant and the necessary collecting and intercepting sewers, pumping stations, force mains and other appurtenances in connection therewith, all when and as approved by the Michigan Department of Health to permit treatment for the sewage of the City before its discharge to state waters"*. The City failed to comply with this Order and the Commission filed a bill of complaint on December 9, 1939, to enforce it. After an extended trial the Circuit Court denied the relief sought by the Commission and the matter was appealed to the Supreme Court. In the course of its opinion (**Stream Control Commission vs. Port Huron**, 305, Mich. 1953), reversing the decision of the lower court and validating the Order of the Commission, the Supreme Court referred to the agreement made by the City that construction of the sewage plant would not materially reduce pollution in the river and that its present method of sewage disposal did not create a public nuisance to the people residing along the river as well as those in the cities of Marysville, St. Clair, Marine City and Algonac situated within 30 miles below Port Huron. In disposing of this contention, the court stated (p. 157):

> *"The record contains sufficient testimony to substantiate the State's contention that the present raw sewage disposal method is a constant menace to the health and well-being of the down-river communities as well as to tourists. This evidence clearly justifies the Commission's order. Under the authority of the City of Niles case, supra, where similar arguments were advanced, it is no defense to a statutory charge of river-water pollution that others have or are contributing to that condition."*

A contention made by the City consisted of invoking the doctrines of "balancing of equities" and "comparative injury". These doctrines are always invoked when a number of municipalities or industries contribute to the pollution of a body of water, each one claiming that it should not be required to abate its contribution to the pollution until the others are required to do likewise. In disposing of this contention the Supreme Court said (p. 157-158):

> *"Even if we should concur with the trial judge in his conclusion that a 'balancing of equities' favors the city, this is not a proper case for the application of that doctrine. The doctrine of 'comparative injury' should be confined to those situations where the plaintiff can be substantially compensated. This principle is distinguished in City of Harrisonville vs. W. S. Dickey Clay Manufacturing Company, 289 U.S. 334, 337 (53 Sup. Ct. 602, 77 L. Ed. 1208)."*

* * * * * * * * * *

> *"The doctrine of 'comparative injury' should not be invoked to justify the continuance of an act that tends to impair public health."*

Another contention made by the City of Port Huron was its financial inability to comply with the Order. In disposing of this issue against the City, the court stated (p. 159):

> *"The act creating the Commission was under the police power vested in the state, and the order in question was not arbitrary to unreasonable but became necessary by reason of the previous refusal of the City of Port Huron to stop pollution of the St. Clair and Black rivers. The evidence justified the order of the Commission, and the decree entered below must be vacated.*
>
> *"We are not unmindful of the situation caused by war conditions and the fact that the city of Port Huron will have difficulty in complying with the Commission's order due to necessary materials now required for war purposes. This however, does not, and should not, prevent the city from immediately taking those steps necessary to insure the carrying out of the mandate of the Commission, but a reasonable time should be allowed for completion of the project. We apprehend that the State and city can agree upon the time that is necessary, and if they cannot, this is a matter which can be determined by the trial judge upon proper proofs."*

The City of Port Huron, however, failed to comply with the order of the Supreme Court and consequently the Attorney General filed a motion for final process to enforce the decree. The court rendered its opinion in **People ex rel Stream Control Commission vs. City of Port Huron**, 323 Mich. 541. In a per curium opinion reviewing the events that had occurred including reference to war conditions that had made it impossible for the City to procure necessary materials for construction and that time was required for this purpose, and pointing out that the City had authorized the issuance of bonds totalling $1,600,000 for construction of the sewage disposal plant, the court stated:

> *"This phase of the situation presents a matter for practical consideration. The problem is one that cannot be solved other than by the construction of proper facilities necessary for the treatment of the raw sewage. . . The condition existing is one, as indicated in the prior opinion of this court, that should be remedied as soon as possible. If the course the city commission claims it is pursuing is followed with reasonable diligence, it seems clear that the desired result can be accomplished in the not far distant future. . . It seems expedient now that a definite date should be fixed prior to which the sewage disposal plant, the intercepting sewers and other necessary appurtenances shall be completed so that the existing situation may be ended.*
>
> *"The injunctive relief sought by the motion of the attorney general will be granted effective as of October 1, 1950."*

Even this, however, did not end the controversy because the City of Port Huron experienced difficulty in selling the bonds to raise the money for construction of the works. Apparently the bonding houses wanted a decision from the State Supreme Court validating the proposed bonds. Consequently, upon the city treasurer's refusal to countersign the bonds, mandamus proceedings were initiated and the matter was decided by the Supreme Court in **Port Huron Mayor vs. Treasurer**, 328 Mich. 99. In its opinion the court reviewed the prior proceedings, the various resolutions and the ordinances adopted by the City for the issuance of the bonds. The court pinpointed the critical issue as follows (p. 106):

> *"The most important question raised by the pleadings is whether the issuance of the general obligation bonds of $1,600,000 must be approved by a 3/5 majority of the qualified electors of the city of Port Huron after due notice has been given to them in the same manner and to the extent that is required for issuance of other general obligation bonds issued under the charter of the city of Port Huron and by the home rule act."*

The bonds had not been submitted to the electors for approval and thus the court was faced with the responsibility of deciding whether its previous Orders could be complied with without reference to a referendum for the issuance of the bonds. Act 320, Public Acts of 1927, authorized the legislative bodies of municipalities to issue and sell bonds necessary for the construction of sewage disposal plants *"whenever a court of competent jurisdiction in this State shall have ordered the installation of a sewage or garbage disposal system in any of the governmental agencies or municipalities herein mentioned and the plans therefore shall have been prepared and approved by the state commissioner of health. . ."*

Another statute known as the Municipal Finance Act, namely Act 373, Public Acts of 1925, contained the same provision with reference to the construction of "necessary storm and sanitary sewers".

After reviewing the various authorities, the court held that whenever a municipality finds it necessary to raise money for the issuance of bonds for the purpose of complying with a court order involving the public health of the State, no referendum of approval by the people is necessary. Its opinion on this point stated:

> *"The action of the plaintiffs was in strict accord with our pre-emptory order for the installation of a sewage treatment system in Port Huron. The proposed bond issue was not to raise money for ordinary municipal purposes or improvements, but to carry out the order of this Court, and prevent defendant from further polluting public streams and endangering the health and comfort not only of its own inhabitants but also of all others in any way affected by the pollution of the waters by the filth from the Port Huron sewers. This no longer created solely a problem of Port Huron but one of the State and this may have been the reason for enactment of Act No. 320, supra, sections of which we have quoted. The order was for the protection of the people of the State of Michigan. It transcended local purposes.*
>
> *"Claims of defendant that notice and a vote of the electors of Port Huron were necessary are fully answered by sections 7 and 8 of P.A. 1927, No. 320, supra. The city of Port Huron was bound to carry out the order of this court, which confirmed the previous order of the Stream Control Commission. There was neither necessity, occasion, nor any reason to publish the resolution authorizing the issuance of the bonds, nor, as previously stated, did it require the vote of 3/5 of the electors."* (Emphasis supplied.)

Another point raised was that the levying of the tax for the payment of such bonds would exceed the tax limitations provided by the city charter. This is a contention which is usually made by municipalities whenever they are faced with complying with an Order of the Water Resources Commission. In its opinion the court rejected this contention by holding that there is ample authority in Act 320, Public Acts of 1927, to levy taxes for the purposes mentioned in that statute; and that even though the tax limitations were exceeded, such defense is not valid when the City is required to comply with a court order.

The Supreme Court thereupon issued its writ of mandamus ordering the city treasurer to countersign the bonds and in due time the sewage disposal system of the City of Port Huron was built and is now in operation.

The series of cases referred to has paved the way for enforcement of Water Resources Commission Orders and has enabled Michigan municipalities to finance construction of projects necessary to comply with Commission Orders. The Water Resources Commission has secured court orders directing 26 units of government in the Lake Michigan Basin to abate pollution of the waters of the state by the construction of sewage treatment facilities and court action is now underway against 4 units of government.

In addition, the Director of the Department of Public Health, acting pursuant to authority vested in him by Act 98, Public Acts of 1913 and Act 219, Public Acts of 1949, has prohibited the extension of municipal sewer systems and additional connections to existing systems where such is deemed necessary to control pollution and protect public health. The authority of the Director to so act has been upheld by Michigan court decisions.

Financial inability in the State of Michigan is not a defense against the abatement of a nuisance either by private citizens or by a municipal entity.

CHAPTER II

Pollution Control Program

Administration of water pollution control functions in Michigan necessarily follows the division of statutory responsibility set forth in the previously cited statutes subject to correlation, wherever possible, of member department interest and objectives with those of the Water Resources Commission. The Water Resources Commission and the Department of Public Health and their respective staffs carry the principal burden of water pollution control in Michigan at the state level.

Water Resources Commission Pollution Control Program

The goal and objective of the Michigan Water Resources Commission is to bring all existing unlawful pollution under continuing effective control and prevent the development of unlawful pollution from new sources, population growths, or increased industrial expansion and, where such incidents occur, limit their duration and intensity to the fullest extent consistent with requirements of the Water Resources Commission statute. Under the Michigan statute (Appendix A), it is unlawful for any person directly or indirectly to discharge into the waters of the state any substance which is or may become injurious to the public health, safety or welfare; or which is or may become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being or may be made of such waters; or which is or may become injurious to the value or utility of riparian lands; or which is or may become injurious to livestock, wild animals, birds, fish, aquatic life or plants or the growth or propagation thereof be prevented or injuriously affected; or whereby the value of fish and game is or may be destroyed or impaired. The discharge of any raw sewage of human origin, directly or indirectly into any waters of the state is prima facie evidence of a violation of the statute unless such discharge is permitted by an Order, rule or regulation of the Water Resources Commission.

Where inadequacies in control of waste discharges are determined to exist, an opportunity is provided for establishment of voluntary corrective action. When it appears to the Michigan Water Resources Commission that a voluntary program will not be successful or may not be accomplished within a reasonable time period, statutory procedures are initiated. Orders adopted contain specific effluent restrictions and specific dates for approval of construction plans and specifications, awarding of construction contracts and commencement of construction, and the completion of construction and attainment of pollution abatement as required by the Order.

Sewerage systems must be developed on the basis of separate sewers for storm water and sanitary waste water. When at all feasible, separated sanitary wastewater systems shall not be discharged into combined systems. If such discharge does occur, control facilities must be developed on the combined system so as to protect present and future water uses of the receiving waters consistent with the requirements of the Water Resources Commission statute. Problems associated with the overflow of storm and sanitary waste from existing combined sewerage systems to public waters must be corrected.

Nutrient discharges, particularly with respect to phosphates, to public waters must be controlled. Persons proposing to make a new or increased use of waters of the state for waste disposal purposes are required, coincident with the new or increased use, to utilize such technology and processes which are known for the removal of phosphorus compounds and as a long-term objective, all existing waste dischargers will be required to provide facilities for the removal of phosphorus compounds by June 1, 1977.

The discharge of sanitary waste from recreational watercraft will be controlled by rules and regulations to be adopted by the Water Resources Commission. Proposed rules and regulations (Appendix B) have been presented at a public hearing and final action is scheduled prior to June 1, 1968.

The Michigan Water Resources Commission will prevent the development of new problems by continued implementation of Section 8 (b) of its statute which requires the filing of a statement of use by any person proposing to make a new or substantial increase in use of waters of the state for waste disposal purposes. The Commission, upon receipt of a statement, makes an Order stating such minimum restrictions as may be necessary to guard adequately against unlawful uses of waters of the state.

Water quality standards for water uses of all Inter-(Appendix C) and intrastate (Appendix D) waters have been adopted. Water use designation, together with a plan of implementation and enforcement of the standards have been adopted for the interstate waters. Public hearings are now being held prior to the designation of waters uses for the intrastate waters. All public hearings will be completed by November 1, 1968. Designation of all water uses to be protected by the intrastate standards within the state is scheduled to be completed by January 1, 1969.

On interstate waters, where noncompliance with the standards is determined to exist as the result of a discharge from an existing municipal wastewater treatment plant, treatment facilities adequate for meeting established water quality standards must be provided no later than June 1, 1972. Secondary treatment is required as a minimum unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with present and future water uses. Exception to the requirement for at least secondary treatment must be justified to the satisfaction of the Michigan Water Resources Commission and the Federal Water Pollution Control Administration. Presently identified existing discharges of raw sewage of human origin to public waters must be corrected by June 1, 1972. Year-round disinfection of all final effluents from municipal sewage treatment plants is required. Industrial waste discharges must meet the same effluent requirements as municipal waste effluents and industrial waste problems identified in the interstate plan reports must, no later than June 1, 1970, have adequate treatment or control facilities. Problems associated with the overflow of storm and sanitary waste from existing combined sewerage systems must be corrected no later than June 1, 1977.

The Water Resources Commission staff inspects each incipient pollution problem regularly. All Orders now adopted by the Commission, to both industries and municipalities, require routine analysis and reporting of the quality of wastes discharged to public waters. In addition surface water quality and waste effluents are monitored so as to identify the need for corrective action to abate existing problems and whenever possible so as to detect and identify the approach of pollution conditions in time to initiate appropriate corrective action prior to the development of a statutory injury. The Water Resources Commission staff reviews and approves or rejects plans for industrial waste treatment or control facilities and counsels with management on industrial waste treatment or disposal problems. It develops appropriate restrictions and time schedules for Commission approval to correct or prevent pollution problems and participates in enforcement procedures initiated by the Commission through statutory hearings and enforcement of Commission Orders in court when voluntary compliance is not forthcoming.

DEPARTMENT OF PUBLIC HEALTH POLLUTION CONTROL PROGRAM

The Department of Public Health, acting through its Division of Engineering, exercises supervisory control over all public sewerage systems. The Director of the Department is required by statute, Act 98, Public Acts of 1913, as amended, to *"exercise due care to see that all sewerage systems are properly planned, constructed and operated so as to prevent unlawful pollution of the streams, lakes, and other water resources of the state"*. The companion statute, Act 245, Public Acts of 1929, as amended, defines unlawful pollution and authorizes the Water Resources Commission to *"establish such pollution standards for lakes, rivers, streams, and other waters of the state in relation to the public use to which they are or may be put, as it shall deem necessary"*. Such pollution standards and the water quality criteria relating to the public uses, currently being promulgated for both interstate and intrastate streams, provide the framework upon which decisions are made and actions taken in relation to the planning, design, construction and operation of all sewer systems and treatment works. Elements of this supervisory program include the following:

Facilities Planning and Approval

1. Review engineering reports establishing the basis of design for projects involving collection and treatment of waste water and consult with the engineers and municipal officials on elements of the proposed design prior to development of plans and specifications for the project, require modification of proposed design where appropriate and, when found to be satisfactory, approve same.

2. Review, approve or reject and secure changes in plans and specifications submitted for new municipal systems or for changes in existing systems, both for collection and treatment. No public sewerage system may be built or altered without specific approval by construction permit.

3. Conducts inspections to determine that construction of public sewerage systems conforms to approved plans and specifications.

4. Require reduction of overflows from existing combined sewer systems. Adoption of accelerated programs for effective control of overflows from such systems is strongly urged. Progress has been made in several communities by sewer separation

5. Require municipal rather than private ownership of all sewerage systems serving the public in the belief that more dependable and effective operation and overall pollution control is thereby assured.

6. Counsels with officials of municipalities and their consulting engineer agents as to the need and methods for collection and treatment of waste water.

7. Strongly encourage and, where appropriate, require the development of multi-community area planning to provide effective services and pollution control facilities utilizing sound management principles. Many such areas are currently served by an integrated system of sewers, interceptors, and treatment works. Others are being so planned in several areas. Examples are metropolitan areas whose core cities are Battle Creek, Benton Harbor, St. Joseph, Grand Rapids, Jackson, Kalamazoo, Muskegon and Traverse City.

8. Encourage the admission of industrial wastes in municipal sewerage systems where such wastes will not adversely affect the system and its performance in relation to effective pollution control.

9. Foster, encourage and assist communities in the adoption of effective and practical sewer use ordinances for the control of industrial wastes to be admitted to the sewerage system. In many instances, technical assistance and counsel is provided in the location, analyses and evaluation of wastes, particularly those toxic to biological treatment processes and in the development of effective corrective measures and controls. Examples are metal plating wastes at Cadillac, Ludington and Wyoming brought under effective control within the last year.

10. Encourage and, where appropriate, require communities to conduct studies, pilot or plant scale, to provide a dependable basis of design for unusual combinations of industrial and municipal wastes to be treated where sufficient information is not available for design purposes. Such studies were made at Battle Creek for cereal products and paper mill wastes to be treated at the municipal plant. Similarly, require studies, either pilot or plant scale, to develop a basis of design where an extremely high degree of treatment is required. Such a study was completed last year at Jackson.

11. Encourage and assist communities to conduct studies to establish effective methods for removal of phosphates from their wastes at existing treatment works. Such studies were made at Lake Odessa and Whitehall last year.

12. Require facilities for removal of phosphates in the design of new treatment works, consistent with the adopted policy of the Water Resources Commission.

13. Require expansion and improvements of municipal facilities, both for collection and treatment as present capacity is approached, rather than wait until the facilities are overloaded before taking action. Approval of sewer extensions is withheld where additional loadings would exceed the capacity of the system until an acceptable program for relief is officially adopted. "Sewer bans" have been imposed in several such circumstances. Authority for such action has been tested and upheld in the courts.

14. Order changes in facilities or their operation when requirements of the statutes have not been met. Alternatively, cases involving deficiency in facilities are referred to the Water Resources Commission for action.

15. As agent for the Water Resources Commission, review, approve or reject plans submitted for new sewer systems, other than municipal, or for changes in existing ones.

16. Assist and encourage local health departments to effectively direct and control the installation of private sewage disposal systems where public sewer systems are not available for connection.

17. Require construction of separate sanitary sewers for new community systems.

Facility Operation - Supervision, Visitation

1. Require the effective operation of all treatment works, including pumping stations and sewer system appurtenances.

2. Require all municipalities to submit reports monthly on the operation of treatment works. Standard report forms are provided by the Department and each municipality is advised as to the minimum information to be reported and the frequency (number of days per week) of reporting. Included are both physical data and laboratory analyses to establish loadings on the plant, performance of plant units, and the volume and characteristics of the plant effluent. Such information is used to determine effectiveness of overall plant performance, deficiencies of component facilities, capacity reserves for additional loadings, and operational problems and shortcomings. Action is taken to assist in corrective measures and to require correction.

3. Supervise operation by on-site inspection, instruction and consultation with plant operating personnel. Adequate services of this nature requires visitation once during each 3 months on the average.

Operator Certification and Training

1 Require all municipalities to employ operators whose competency has been certified by the Department. By statute, it is mandatory that the person in charge of the plant be so certified. Over 600 operators have been so certified on the basis of education, experience, and written examinations. About 200 operators with plant experience are examined each year. A high percentage of applicants are certified operators seeking to establish qualifications for a higher plant classification.

2. Conduct formal group training sessions to impart specific information related to effective operational control, to provide opportunity for exchange of information and experience and to provide incentives for self-study and development. Over 325 operators attend a 2-day meeting each year conducted by Department engineers and chemists. A series of four 5-day sessions in laboratory procedures involving chemical and bacteriological analyses are currently being conducted by the Department staff. Eighty operators who presently perform such tests at their plants are registered. Evening courses are held throughout the state for a 12-week period in mathematics, chemistry, or hydraulics as applied to wastewater works operation, in a cooperative program with other agencies and organizations. Special courses in process control, safety and related areas are sponsored with other groups.

3. Encourage operators to meet on a regular schedule, usually about once monthly, on their own initiative to exchange information on plant operational problems and experiences and to invite speakers to discuss selected subjects related to facilities design and maintenance, laboratory equipment, etc. About 10 such groups meet regularly with about 200 operators participating.

Disinfection Policy and Practice

1. Require all municipalities to disinfect the plant effluent before discharge to the surface waters of the state. This policy was adopted in January 1967, (Appendix E). Virtually all communities in the state are conforming to this policy.

2. Require the provision of adequate facilities and their operation, monitoring and testing in such a manner as to assure continuous effective disinfection.

3. Require regular reporting on forms furnished by the Department of chlorine used daily, results of chlorine residual readings, and related information. Over 60 communities are performing bacteriological analyses on the chlorinated effluent as a check on the chlorine dosage and chlorine residual regimens. Many other small communities are currently planning to apply additional refinements in control this year.

STUDIES ON REMOVAL OF PHOSPHATES FROM WASTE WATER AT MUNICIPAL TREATMENT PLANTS

During the past year studies have been made by several Michigan municipalities on removal of phosphates from the waste water collected in their community sewer systems. Two general methods were utilized: One involving the addition of iron salts either to the raw sewage or activated sludge with or without the addition of polymers; the other involving management of the activated sludge process without chemical additions. The latter method is an extension and adaptation of the work conducted at San Antonio and other installations as reported by the Federal Water Pollution Control Administration. The central objectives of these studies were:

1. To determine phosphate concentrations and loadings at several municipal treatment plants.

2. To determine the amenability of wastes at various locations to phosphate removal by one or more methods in relation to primary sedimentation, trickling filters and activated sludge.

3. To explore the effect of chemical additions for phosphate removal on the removal of BOD and suspended matter at primary, trickling filter and activated sludge installations.

4. To study the degree of compatibility of iron salts with biological and chemical (polymer) treatment systems, when added for phosphate removal.

5. To furnish information upon which design of facilities for phosphate removal may reasonably be predicated.

Studies of this nature were prompted by:

1. The acute and pressing need to develop base line data for the design and management of facilities at several existing wastewater treatment plants for removal of a high percentage of phosphates from the plant effluents.
2. Preliminary studies by the Dow Chemical Company at the Midland, Michigan wastewater treatment plant in February 1967 indicating that iron salts held promise for effective phosphate removal in both primary and biological treatment systems.
3. The need to apply the principles developed in the San Antonio, Texas studies to individual, peculiar circumstances in order to determine how such principales might be applied effectively in the design of biological treatment facilities with a high degree of phosphate removal for such circumstances.

A variety of study methods and procedures were followed. Some involved bench studies only, using jar tests on the wastes undergoing treatment at the plant; others included full-scale plant operation applying the knowledge acquired in the bench work; and others were conducted at pilot plants built to establish a basis of design for facilities to be added.

The first of these studies was conducted at Grayling, a resort community of less than 2,000 resident population (Appendix F). Bench studies indicated that 90% or more of total phosphates could be removed from the raw wastes by plain sedimentation with the addition of about 20 mg/l of ferrous chloride as iron, an equal amount of sodium hydroxide and about 0.5 mg/l of an anionic polymer. It was indicated that the caustic could be added a few seconds following quick mix of the iron salt with the raw sewage and that a selected polymer, if added following an interval of about 5 minutes, would form a good floc after a short period of slow flocculation and would effectively remove the phosphates. A very low order of removal of total phosphates was experienced when no polymer was added. These principles were applied to full-plant scale operation within the limitations of the facilities. The iron and caustic were added to the sewage at the lift station with no formal mixing facilities and the polymer was added at the entrance to the settling tank with crude and temporarily rigged mixing equipment. During the period of plant scale application the plant was grossly overloaded hydraulically by reason of seasonal influx of tourists and National Guard encampment. In spite of these adverse circumstances total phosphate removal ranged between 60% and 80% with a most probable mean value of 72%. Correspondingly, suspended solids removal ranged from 60% to 87% with a mean value of 78% representing an increase of about 27% compared with performance when chemicals were not added. Removal of 5-day BOD increased from a mean value of about 40% before and after the study to about 58% during the study. It should be noted here that the raw sludge was hauled to a land disposal site.

Work of a similar nature, both in bench studies with jar tests and full-scale plant operation, was performed at the Village of Lake Odessa (Appendix G). Here the municipal treatment facilities include trickling filters and sludge digestion facilities. The same chemicals were applied to the raw sewage as at Grayling in about the same concentration except that the dosage rates of the ferrous chloride were less effectively controlled, resulting in rather widely fluctuating dosage rates, ranging from daily averages of about 15 mg/l to 60 mg/l. No mixing or flocculation equipment was installed. Wastes varied widely from day to day and week to week in strength and quantities by reason of changing admixtures of wastes from a food processing plant. Total period of the plant scale study both with and without chemical treatment was 87 days including 33 days when valid operating data were obtained under controlled chemical feeding conditions. These data generally confirmed Grayling observations although removal of total phosphates, 5-day BOD and suspended solids by primary sedimentation was somewhat lower. It was further indicated that:

1. Trickling filter performance is enhanced, as measured by 5-day BOD and suspended solids removal, by this regime of chemical additions to the raw sewage. Most probable mean values for overall plant suspended solids removal increased from about 78% without chemical additives to about 89% with chemicals; Correspondingly, BOD removal increased from about 60% to about 80%.

2. Overall plant reduction of total phosphates was quite stable with values generally between 75% and 92% removal and a mean value of 82%.

3. Total phosphates in the digester supernatant were quite low with most values below 75 mg/l. This appears to confirm the findings of F. A. Thomas as reported in his published work conducted at the treatment plant for the community of Uster in Zurich, Switzerland.

Other work involving use of ferrous chloride and polymers was performed last summer at the Village of Whitehall and the City of Traverse City. The studies thus far have been bench scale, employing jar tests similar to those at Grayling and Lake Odessa. Results have generally confirmed the earlier findings at the other 2 plants. At Traverse City it is planned to explore further, by pilot plant studies, how to most effectively remove phosphates from their peculiar wastes in a biological treatment process requiring a high order of removal of BOD and suspended matter. The municipal sewage includes substantial quantities of wastes from cherry processing operations.

Rather extensive studies of phosphate removal by metallic ion precipitation in a biological system were commenced last September at the municipal activated sludge plant of the City of Warren. A pilot plant was installed as the first step in a study to establish a basis of design for extending the present capabilities of the plant to meet an effluent requirement of 8 mg/l 20-day BOD and 80% removal of total phosphates. Pilot plant components consist of activated sludge units followed by rapid sand filters. Ferrous chloride or aluminum sulfate were fed into the aeration tanks near their point of overflow at about 15 mg/l. No polymers were added. At the end of the first 3 months of daily operation and testing it was established that:

1. Total phosphates precipitated by metallic ions were removed by activated sludge in the order of 70% or higher consistently and an additional 10% or more was removed by the rapid sand filters.
2. The addition of iron or aluminum directly in the mixed liquor for phosphate removal is compatible with the activated sludge process when operated for high degree BOD removal.

Other work of a pilot plant nature is being conducted by the cities of Detroit and Trenton under demonstration grants from the Federal Water Pollution Control Administration. Both projects utilize activated sludge. Data obtained will be used, hopefully, for the design of formal facilities to be added to the existing primary plants for improved treatment, including phosphate removal. The pilot plant at Detroit has a nominal capacity in excess of 100 gpm and is very flexible and adaptable to a wide variety of control patterns and methods. Both plants have been operating for about 4 months. Biologic methods utilized to date for phosphate removal conform generally with the San Antonio procedures. Although results thus far have not demonstrated a consistent high order of removal of phosphates, they are at this point inconclusive and indicate that much more work will be required to establish predictable patterns of phosphate removal by these methods on these wastes.

In addition to the specific installations which we have discussed here, there are many treatment plants in Michigan where tests have been performed to establish the level of phosphates in the municipal wastes, their variations and some of their specific characteristics. In some of these plants, jar tests have been made in the laboratory using chemical additives to determine amenability of the wastes and dosage rates required for phosphate removal. In others, preliminary jar test studies have been made on activated sludge without chemical additives. Similar studies are planned at several plants involving a wide variety of conditions, methods, procedures and objectives.

As each study progresses it will add in some way to our knowledge of the mechanisms by which phosphates may be effectively and economically removed as a companion process to meet the overall treatment objectives now being established.

CHAPTER III

DISCHARGES TO SURFACE WATERS

Industries

The Water Resources Commission staff has under surveillance 231 industries which discharge treated or untreated waste water to public waters in the Lake Michigan Basin. The 231 industries that discharge waste effluents to surface waters are listed in Appendix H, together with their pollution status rating, type of treatment provided, waste effluent data where such is available and formal abatement action taken by the Commission. The pollution status ratings are updated annually and represent the Water Resources Commission staff's effort to fairly appraise each incipient pollution problem as indicated by a review of operating reports, observations, inspections or surveys during the preceding calendar year. The ratings are by letter code as follows:

A. Control adequate
B. Control provided - adequacy not established
C. No control - need not established
D. Control provided - protection unreliable
E. Control inadequate

c - construction underway
p - plans being prepared
s - studies underway

Table 1 summarizes the pollution status ratings of the 16 industries which have effluent discharges directly to Lake Michigan:

Table 1

Pollution Status Rating	Type of Industry					
	Chemicals	Electric Power	Food and Packing	Minerals	Paper	Total
A	2	3	2	2		9
B			1			1
B - studies in progress					1	1
C						
D						
D - construction in progress					1	1
E			1			1
No rating given		1	1	1		3
Total	2	4	5	3	2	16

As shown by the table, only 2 of the 16 have D or E pollution status ratings.

In addition to the 16 industries which have effluent discharges directly to Lake Michigan, 215 have effluent discharges to inland surface waters tributary to Lake Michigan. The pollution status ratings for these industries are summarized by tributary river basins in Table 2, 56 have D or E pollution status ratings.

Table 2
Summary of Industrial Surface Water Discharges in the Lake Michigan Basin
April 1, 1967

Pollution Status Rating, April 1, 1967 / River Basin	Menominee (U.P.)	Escanaba (U.P.)	Rapid (U.P.)	Pine	Elk	Boardman	Betsie	Manistee	Pere Marquette	White	Muskegon	Grand	Black Holland	Kalamazoo	Black S. Haven	Paw Paw	St. Joseph	Minor Drainage Areas	Sub Total	Total
A	6		1		2	1			2	1	7	19	2	17	2	7	8	3	78	
C Construction in progress																			0	
P Plans being prepared																	1		1	
S Studies underway					1			1											2	81
B	1					1	1		1		3	15	3	7		4	2	1	39	
C Construction in progress				1						1		2		3					7	
P Plans being prepared																	2		2	
S Studies underway					1			1			1			1					4	52
C										1		2					1		4	
C Construction in progress																			0	
P Plans being prepared																			0	
S Studies underway																			0	4
D							1		1		1	7	1	1		1	1		14	
C Construction in progress											1		1	1			4		7	
P Plans being prepared														1			1		2	
S Studies underway												2							2	25
E				2		2					1	1	1	7		1	1	1	17	
C Construction in progress												1		1					2	
P Plans being prepared								1			2	1	1	2					7	
S Studies underway		1										1	1	1			1		5	31
No Rating Given	1						1	3			4	11	3	4	1	1	[illegible]		35	35
Total	8	1	1	3	4	4	3	6	4	3	20	62	13	46	3	14	28	5		228*

*Note - The 228 status ratings summarized in this table reflect the ratings for 215 industries, 13 of which have dual ratings.

Governmental Units

The 193 governmental units that discharge waste effluents to public waters are listed in Appendix I, together with the type of treatment provided, waste effluent data where such is available, abatement action taken and present status. The data was obtained from records of the Michigan Department of Public Health and the files of the Michigan Water Resources Commission. The waste effluent data reflects the average for the month of August 1967. Only 6 discharge their waste effluent directly to Lake Michigan. The remainder (188) discharge to various tributaries, some within a short distance from the lake and others several hundred miles inland.

The 6 with a discharge to Lake Michigan are:

Governmental Unit	Population	Treatment
Gladstone	5,400	Primary
Harbor Pointe	800	Primary (septic tank)
Harbor Springs	1,430	Primary (fine screen)
Petoskey	6,400	Primary (chemical precipitation)
Suttons Bay	420	Secondary (lagoons)
Wequetonsing	1,000	Primary (Imhoff tank)

Approximately 2.3 million people live in the Michigan portion of the Lake Michigan Basin. A large percentage (43%) live in rural areas where collection and treatment of waste water by a central system is not necessary or feasible at the present time. They, in the most part, are served by individual systems, such as a septic tank followed by a subsurface percolation field. All but 4% of the population readily accessible to central systems are served by formal collection and treatment systems with approximately 72% of the population serviced receiving treatment by secondary biological processes. Fifty-three governmental units have been identified as permitting, allowing or suffering the discharge of raw sewage of human origin to public waters and in all instances the Water Resources Commission has, as a minimum, held an initial informal conference with the responsible governmental unit to discuss and encourage an appropriate water pollution abatement program. This initial action has been followed in 22 instances by formal statutory enforcement proceedings. The others are currently progressing satisfactorily but remain under continuing review.

CHAPTER IV

LAKE MICHIGAN BASIN DESCRIPTION AND WATER USES

BASIN DESCRIPTION

Introduction

Lake Michigan is the sixth largest fresh water lake on earth, with an area of 22,400 square miles and a volume of 1,116 cubic miles. The lake surface elevation averages about 580 feet above sea level, common with Lake Huron. It is divided into 2 deep-water basins, by a submerged ridge running roughly from Grand Haven to Milwaukee. The average depth of the ridge is approximately 232 feet. The maximum depth of the lake, 923 feet, is in the northern basin. The land drainage area is 45,460 square miles, 64% of which is in Michigan. The lake surface accounts for over 31% of the total drainage area. Discharge of Lake Michigan occurs through the broad, deep Straits of Mackinac (no measurable gradient) into Lake Huron, and by diversion into the Chicago Sanitary and Ship Canal and subsequently into the Mississippi River system. The latter discharge is approximately 3,100 to 3,200 cfs (combined direct diversion and domestic pumpage). The normal outward flow into Lake Huron has not been precisely determined. It is estimated to be between approximately 40,000 and 55,000 cfs.

Lake Michigan occupies a great valley in the Paleozoic sedimentary rocks which lap onto the southern edge of the Pre-Cambrian Canadian Shield. This valley originated in pre-glacial times and in rock least resistant to erosion. Jack L. Hough in his Geology of the Great Lakes (1958) suggests that the existence and orientation of this feature exerted a strong influence on subsequent glacial ice movement which was responsible for the final shaping of the Lake Michigan Basin. The existing Great Lakes are of comparatively recent origin, the present levels having been reached only about 2,500 years ago.

The coastline of Lake Michigan, with the exception of Green Bay, Little Traverse Bay and Grand Traverse Bay is quite regular. Lake Michigan is characterized by few natural good harbors; however, the outlets of drowned estuary lakes in the mouths of several Michigan rivers have been improved and protected to provide excellent facilities.

Some of the Nation's finest beaches are found along the east coast of Lake Michigan. The 1,058 miles of Michigan shoreline are comprised of relatively limited areas of sedimentary rock outcrops and shingle beaches; some areas of till and clay bluff, and many hundreds of miles of sand. Sands are either piled high in the great dunes or low and undulating in the beach ridges. Sands that slope gradually into deeper waters, provide an excellent swimming facility.

Lake Levels

Knowledge of the hydrology of Lake Michigan is essential for the solution of most practical problems pertaining to this body of water. The United States Lake Survey has recorded water levels for over 100 years, and has made detailed surveys of the bottom topography. The Great Lakes Research Institute began a continuing program of fundamental investigations in 1954.

The principal natural factors which affect the longer-period fluctuations of the level of Lake Michigan are precipitation and evaporation. Precipitation falling directly on the lake surface raises the surface immediately. Precipitation falling on the land surface of the drainage area has a delayed and variable effect. Average annual precipitation varies from about 28 inches on the northern part of the lake to about 32 inches on the southern part. Evaporation from the lake surface has been estimated as being approximately equal to precipitation upon it.

The levels of Lakes Michigan and Huron for 105 years (1860-1965) have ranged between 583.68 feet (1886) and 577.09 feet (1964), a range of 6.59 feet. The highest modern level occurred in 1952, 582.69 feet. The level of Lakes Michigan and Huron is affected by the diversion at Chicago of 3,100 cfs (withdrawal) and the diversion into Lake Superior of 5,000 cfs via the Long Lake and Ogoli projects. The net effect of both diversions is to raise the levels of Lakes Michigan and Huron about 0.14 foot above what it would be without withdrawals and additions.

Levels follow a seasonal pattern with highs generally occurring in summer and lows in winter or early spring. With any single year, variations average about 1.1 foot.

Lake Currents

Surface currents are produced mainly by wind action and differences in barometric pressure over different parts of the lake. Brief windstorms may create surface waves which cause strong local currents of short duration. Strong winds of longer duration will produce a transfer of water toward the leeward shore and a temporary circulation which is affected by the shape and topography of the lake basin. Close to shore in shallow water the alongshore drift produced by moderate waves approaching at an oblique angle may reach velocities of 1 or 2 miles per hour. Such water movements are of a temporary nature. In addition, there appears to be patterns of permanent, or at least seasonal, circulation involving a slow drift of the water.

There is a southward drift along the western side of the lake which continues around the south end and turns northward on the eastern side, where it becomes more pronounced. Around the Beaver Island group in the north and in the major southern basin there are counter-clock-wise swirls. Between these swirls the surface water tends to move eastward along lines which are curved with their convex sides to the south.

The prevailing westerly winds, coupled with the flow toward the outlet, are considered the cause of the above flow patterns. Some authorities dispute the counter-clock-wise swirls described above. Northeasterly winds can alter normal flow patterns. At times the flow through the Straits of Mackinac is temporarily reversed.

Population

There were more than 2,250,000 people in the Michigan portion of the Lake Michigan Basin in 1960. The population varied from the densely settled metropolitan areas of Grand Rapids and Lansing to the virtually uninhabited State and Federal forests in the Upper Peninsula. The area can be divided into the 3 traditional zones of Michigan: the relatively densely settled and intensely developed souther Lower Peninsula had 26% of the land area and 83% of the 1960 population, while the moderately populated northern Lower Peninsula had 21% of the land and 11% of the population, and the sparsely settled Upper Peninsula had 17% of the land and only 6% of the 1960 population. The 1960 population densities were below 17 people per square mile for the Upper Peninsula, nearly 27 people per square mile for the northern Lower Peninsula and over 150 people per square mile for the southern Lower Peninsula. Based upon past history, the population will be approximately 2,800,000 in this area in 1980, with the bulk of this increase in the southern Lower Peninsula.

Economy

Bogue and Beales' Economic Areas of the United States (1961) categorizes the "Western Michigan Lake Shoreline" as a "subregion", the "Upper Peninsula - Eastern" and the "Lower Peninsula - Northwestern" as "areas". Following is a summary of the general economy of these units:

Western Michigan Lake Shoreline

1960 population	976,000 change 1950-1960 24%
Land area	6,662 square miles

The early economy was largely timber oriented. As the great timber resources were cut, the logs were floated to the sawmills located at the mouth of all principal rivers. Around these mills and the docking facilities required to transport the sawn timber, there developed many of the cities of western Michigan--Grand Haven, Muskegon, Manistee, Ludington, Traverse City. With the end of the timber harvest, the sawmill towns were able to convert their economies to a general manufacturing and wholesale and retail trade base. This transition was made possible in a large measure by the existing lake port transportation facilities. There are 2 metropolitan areas in the subregion--Grand Rapids and Muskegon. Grand Rapids made a rather natural transition in its economy--from sawmills to furniture to a modern industrial city, manufacturing a wide range of fabricated metal products, automobile parts, machinery, etc. Muskegon, once one of the world's leading producers of lumber, has become a manufacturing center of engines, automobile parts, foundry products, etc. The smaller cities of the subregion are also manufacturing oriented. Food processing, canning and marketing are a significant segment of the economy. Western Michigan is one of the Nation's leading fruit and vegetable growing regions. This is made possible by the climatic influence of Lake Michigan. Apples, cherries, peaches and pears are the leading tree fruits. Truck farming and small fruit producing are also major agricultural enterprises. The entire west coast of Michigan is used intensively for recreation. Tourism and summer residences furnish a substantial income to non-agricultural workers in rural areas.

Upper Peninsula - Eastern Area

1960 population	128,521 change 1950-1960 3.6%
Land area	7,832 square miles

The general unsuitability of much of the area to agriculture (both climate and soils), the lack of mineral wealth, and its remoteness to population centers are reflected by the sparse population of the eastern Upper Peninsula. Nearly a third of the population is centered in the cities of Escanaba, Menominee and Sault Ste. Marie. All 3 are important ports on the Great Lakes. The past economy of the area was natural resource oriented (timber, fish, recreation). The current economy is based on wood-using industries (pulp, paper, wood products), light manufacturing and recreational facilities, resorts and summer homes. Although farming has declined in general, that remaining is more efficient and more profitable.

Lower Peninsula - Northwestern Area

1960 population	141,019 change 1950-1960 2.6%
Land area	6,147 square miles

The economic history of this area was once timber--the northern Lower Peninsula of Michigan together with areas in other states bordering the Great Lakes was the site of the world's greatest white and red pine forest. This vast region was logged off in the last 4 decades of the 19th Century. During the logging, and for a considerable period afterwards, the most extensive forest fires in this Nation's history ravaged these pine lands, often burning over the same area several times. Not only were the few remaining trees destroyed, but of even more significance was the destruction of the soil. The meager humus and organic matter on the northern sandy soils were consumed. For over a generation the burned lands remained bare and stark. Gradually the burns were re-forested, but not with the original species. The great pine stands were replaced by aspen, oak, pin cherry and jack pine. So great an amount of land was re-forested by these rapid growing, hearty species that they became a valuable resource. Once again wood products utilization is an important aspect of the economy. The great wooded stretches are gaining in economic importance with recent development of an expanding wood using industry (particle board, pulp and paper). Farming is an important part of the economy, providing employment for nearly 1/3 of the population. The trade, services, construction and employment by the recreation industry is increasing yearly.

Agriculture

Of the 48 counties which lie wholly or partially in the Lake Michigan Basin, dairying is the most important type of agricultural activity in 25 of them. Field crop production is the most important in 13 of the counties, fruit production in 8 of the counties and poultry production and livestock production in 1 of the counties each.

Land Use

The land use of the Lake Michigan basin ranges from the intensive use of the metropolitan areas of the southern Lower Peninsula to the extensive use of the forests in the northern Lower Peninsula and the Upper Peninsula. The dominant land use in the southern Lower Peninsula is farmland, with over 80% of some counties devoted to agricultural use. The percentage of forest land ranges from below 9% in Clinton County in the southern Lower Peninsula to over 90% in Roscommon County in the northern Lower Peninsula and in several counties in the Upper Peninsula. The value and use of the land is reflected in the fact that the percentage of publicly-owned land ranges from a low of 0.01% for VanBuren County in the southern Lower Peninsula to a high of nearly 61% for Schoolcraft County in the Upper Peninsula.

WATER USES

The waters of the Lake Michigan Basin serve a multiplicity of uses. They are used for public water supply, temperature control, waste assimilation, recreation, commercial fishing, commercial navigation and agricultural irrigation.

Public Water Supply

One of the most important uses is for public water supply. The waters of Lake Michigan are of excellent quality for this purpose, being moderate in hardness, very low in turbidity and chlorides, and showing little change from year to year. Twenty three municipalities, with a 1960 population of nearly 650,000 people, use Lake Michigan as a raw water supply. These municipalities withdrew over 90 million gallons a day in 1966.

Cooling Water

There are 6 steam generation plants using Lake Michigan water for cooling purposes, 1 of them utilizing nuclear energy. Three of these plants are owned by municipalities and 3 are privately owned.

Recreation

Water has always been a major focal point for outdoor activities. People seek water in which to swim, fish, hunt, boat and water ski. They seek water beside which to camp, hike. picnic and drive. In addition, they seek water just to look at for aesthetic enjoyment. The Great Lakes Region comprises the largest source of fresh water in the world and has been traditionally utilized for water-oriented recreation. Lake Michigan is the second largest of these lakes and the only one which lies entirely within the boundaries of the United States. It has a total shoreline of 1,661 miles (1,058 in Michigan) about 1,300 miles of which are suitable for recreation. Although 806 of these recreational miles are located in the State of Michigan, only 40 miles or 5% is in public ownership. Lake Michigan's shoreline receives extensive recreational use, especially in the southern Lower Peninsula. Michigan's recreational shoreline supports a full range of recreational activities. Its 806 miles contain 115 miles of beaches and 691 miles of bluffs and sand dunes. There are 14 state parks and thousands of acres of other publicly-owned land adjacent to Lake Michigan. It is estimated that there may be as many as 50,000 seasonal dwellings in the Michigan portion of the Lake Michigan basin, many of which are located along the shore of Lake Michigan.

Boating

Pleasure boating has changed from the luxurious cruise vessels of the early 1900's to the many thousands of recreational watercraft of today. The State of Michigan had a total of 399,000 motor-powered craft registered in 1965. In addition, non-motor-powered craft were estimated at 50,000. There are a considerable number of boats registered in other states that use Michigan waters.

In order to serve the vast flotilla of watercraft using Lake Michigan waters, there are 108 marinas equipped with boat slips, either on or contiguous to Lake Michigan. In addition, there are harbors of refuge located at no more than 30-mile intervals along the established cruising lanes of Lake Michigan.

Sport Fishing

Fall waterfowl hunting and year-round sport fishing activities are popular uses of the waters of Lake Michigan. Many of the offshore islands and Waugoshance Point are famous for their waterfowl shooting. The Lake Michigan sport fishery is supported by the great variety of fish listed below:

- Lake Sturgeon
- Rainbow Trout
- Brown Trout
- Brook Trout
- Northern Pike
- Muskellunge
- Lake Trout
- Cisco
- American Smelt
- Smallmouth Bass
- Largemouth Bass
- Black Crappie
- Bluegill
- Coho Salmon
- Yellow Perch
- Rock Bass
- Walleye
- Carp
- Suckers
- Bullheads

Fishing for yellow perch is by far the most popular use of the fishery. Thousands of anglers line the many navigation piers to take advantage of the abundance of these high value food fish during the year-round open season. Other species of particular importance in the sport fishery are coho salmon, walleyes, smallmouth bass and northern pike. Sport fishermen are fortunate in that the lake provides "deep sea" fishing for such highly valued fish as the lake trout, muskellunge and steelhead. Ice fishing for perch and walleyes is a popular winter pastime on the many bays of Lake Michigan.

Commercial Fishing

The Lake Michigan commercial fishery had its beginning with the Indians and early employees of the fur trading companies. As the land area was settled early in the 19th Century the demand for fishery products increased and new types of gear evolved.

Production reached a peak of 47,356,000 pounds in 1908. Although there have been high peak years, average annual production has not fluctuated widely from 26 million pounds. In recent years, the fishery resource has been marked by changes in the composition of the catch with fish of lower value replacing those of higher value. These changes are generally attributed to predation of the sea lamprey, introduction of exotic species, and in certain instances, over-fishing.

Catches of sturgeon, lake trout, lake herring, and suckers from Lake Michigan have reached all-time lows in recent years. Chubs and yellow perch have maintained or increased their abundance while the exotic species, carp, smelt, and alewife, have increased sharply. It is generally agreed that these changes have been due to biological and economic changes rather than changes in water quality.

The decline of commercial fishing on the Great Lakes is closely associated with what has happened to the lake trout and whitefish. These 2 high-valued fish once represented a bounteous resource. In 1885, 6,431,000 pounds of lake trout were caught in Lake Michigan. Production rose to higher levels in many years and was up to 11,749.000 for Lake Michigan in 1921. This picture changed with the invasion of the Great Lakes by the sea lamprey. The catch of lake trout started to drop rapidly in Lake Michigan around 1947. By 1963, lake trout catches were down--partly because of fishing restrictions--26,000 pounds in Lake Michigan.

Whitefish production has followed a somewhat similar trend. Some 8,653,000 pounds were caught in Lake Michigan in 1885. By 1963 production was down to 298,000 pounds in Lake Michigan.

The situation of the industry brightened to a degree in 1964 and 1965, particularly with regard to the valuable whitefish. Over 846,000 pounds of whitefish were taken from Lake Michigan in 1965. In 1959 only 11,000 pounds were taken from that lake.

The following illustrates the depth distribution of the major species:

Inshore and shallow: Carp, sturgeon, suckers, yellow perch and walleyes

Shallow to intermediate: Lake herring, lake whitefish and smelt

Deep water: Chubs, lake trout (young are shallow to intermediate)

All depths: Alewife

The productivity of shallow areas is high when compared to deep-water productivit The shallow waters of Green Bay and of the narrow band around the shoreline are the most important in relation to the fishery resources. These shallow areas are also important to the life cycles and movements of some of the deep-water species.

For a detailed analysis of the commercial fishery of Green Bay see Michigan Water Resources Commission staff report: Commercial Fishing in the Michigan Waters of Green Bay, October 30, 1963.

Commercial Navigation

Commercial navigation is of great significance to the past, present and the future economy of the Great Lakes region. In the past. settlement patterns and the locations of cities and industrial complexes were either determined by proximity to lake commerce or strongly influenced by it. Much of today's commercial and industrial activity of the Great Lakes region is geared to lake shipments. The potential of the St. Lawrence Seaway is being fulfilled and promises to provide even closer links between the Great Lakes and world markets. With each passing season there are increases in direct foreign shipments, both to and from lake ports.

Although there were few adequate natural harbors in Lake Michigan, improvement of navigation facilities paralleled that of the development of the commercial capabilities. In early times. only canoes, Mackinaw boats and other small sailing vessels used the harbors provided by western Michigan border lakes (Muskegon, White, Pere Marquette, etc.) and these were not greatly hindered by the always present sand bars which partially blocked the entrances to these lakes. But as commerce increased and larger vessels began using Lake Michigan and the developing ports, navigation improvements became a necessity. At first, local citizens assumed the responsibility for these improvements. Sand bars were cut through and lined with cribs or wood piles. This was followed shortly thereafter by the first breakwaters--stout timber cribs, sunk to the lake bottom, filled with rocks and timber-decked. Some of these early efforts remain as a part of the substructure of the existing breakwaters. At South Haven (1868), Holland (1860), and Grand Haven (1857) these early structures have passed or are near the century mark.

As more elaborate improvements became necessary, the costs and engineering capabilities soared beyond the abilities of local citizens. At the direction of Congress, the U. S. Army Corps of Engineers assumed responsiblity for harbor and channel improvements. A Federal assistance project was authorized for Holland as early as 1852. To date 22 Federal projects have been authorized in Michigan on Lake Michigan. Expenditures for these projects have been substantial--over $44,000,000. These costs have been incurred from new work (over $13,000,000), maintenance ($24,447,000) and rehabilitation ($6,575,467). The relatively high figure for maintenance results from annual dredging required at many of the harbors. Littoral movement of shore sediments is a process which is continually filling artificially deepened harbor entrances.

Current freight movements on Lake Michigan are based on intrastate, interstate and international commerce. In 1964, 22,422,595 tons of freight were moved at Michigan ports on Lake Michigan.

An important segment of this movement is by railroad car ferry. Since Lake Michigan provides a geographical interruption to cross-continental rail routes, the ferry service is an essential link in the rail transportation system. Three railroads operate ferry service across Lake Michigan:

The Grand Tunk-Western Railroad, Muskegon to: Milwaukee, Wisconsin
The Chesapeake and Ohio Railroad, Ludington to: Milwaukee, Wisconsin; Manitowoc, Wisconsin and Kewaunee, Wisconsin
The Ann Arbor Railroad, Frankfort to: Manitowoc, Wisconsin: Kewaunee, Wisconsin and Menominee and Manistique, Michigan

CHAPTER V
Part 1

THE RELATIONSHIP BETWEEN THE LAKE MICHIGAN ALEWIFE DIE-OFF AND RESULTING WATER QUALITY

Observations of depressed water quality conditions and increased bacteria counts concurrent with the annual alewife die-off along the Michigan shoreline of Lake Michigan led to a laboratory study of the problem (Appendix J). Six tubs, 3 containing Lake Michigan water and three containing Lansing tap water, were placed in an open area exposed to sunlight. Two of the tubs containing Lake Michigan water and 2 containing Lansing tap water each received 1 freshly dead 6-inch alewife. Chemical, bacteriological, and algal changes were monitored over the next 23 days, from August 16 to September 8, 1967. The dead fish provided an environment which allowed a population explosion of coliform bacteria. Decomposition of the fish tissues resulted in a nutrient release which in turn enabled a dense algal bloom to develop. Coliform and fecal coliform bacteria populations as high as 1,500,000/100 ml and 3,500/100 ml, respectively, developed in the tubs containing a dead alewife.

Abnormally high coliform bacteria populations developed along Lake Michigan beaches during the summer of 1967. The presence of dead alewives was probably a major reason for this abnormality. The high counts partially negate the value of beach bacteria sampling as an indication of sewage contamination.

Phosphate released from the decomposing fish in the tubs was rapid. Each single dead alewife in approximately 6.8 gallons of water released more than 2.0 mg/l soluble orthophosphate as PO_4 within 2 days. Soluble orthophosphate in these tests reached concentrations as high as 6.3 mg/l. The total phosphate released from these 4 fish during the test ranged from a low of 113 mg to a high of 201 mg PO_4 per fish.

In the tubs containing alewives, blooms of small single-celled, green algae developed shortly after nutrient release. In 1 case the algae population grew from less than 100 cells/ml to a maximum of 3,187,800/ml. These exploding populations utilized the available soluble orthophosphate. Concentrations of this phosphorus fraction dropped while total phosphate continued to increase.

One agency has estimated that a few hundred million pounds of alewives died in Lake Michigan during 1967. For the purpose of this report we will use 300 million pounds. Analytical work by the U. S. Bureau of Commercial Fisheries on several groups of alewives has shown that alewives about 6-inches long contain approximately 2.23 grams of phosphorus per pound of fish. Thus, 300 million pounds of dead alewives could release 2,300 tons of phosphates into Lake Michigan. The concentration of soluble orthophosphate as PO_4 commonly claimed sufficient to create nuisance algae conditions in water is 0.03 mg/l. If two-thirds of the released phosphorus was in the form of soluble orthophosphate the potential from this source alone exists to bring approximately 11 cubic miles of phosphorus-free water to the point nuisance algae blooms could occur.

It is generally acknowledged that during the summer the water mass along Michigan's west coast from Benton Harbor-St. Joseph to Little Point Sable is discrete and moves northward unless broken up by strong winds. The U. S. Bureau of Commercial Fisheries' aerial survey showed that most of the dead alewives were concentrated in the southern tip of Lake Michigan and in a band along both shores in the southern two-thirds of the lake. Windrows of dead alewives collect in the shallow wate beach zone. Nutrients from the decomposing fish were released into this discrete, surface water mass which is already enriched by the tributary rivers draining urban and agricultural areas. There are 2,240,000 acre feet of water in Lake Michigan along the shoreline out to the 30-foot depth contour from the Indiana-Michigan state line to the tip of the Leelanau Peninsula. Assuming two-thirds of the phosphorus released during alewife decomposition is available for uptake then only 18,700,000 pounds of decomposing alewives would be necessary to bring that amount of phosphorus-free water to the critical nuisance-algae-producing level. This stretch of shore comprises approximately 20% of the total Lake Michigan coastline. Twenty percent of the estimated alewife die-off of 300 million pounds is 60 million pounds. It seems highly probable that more than the 18,700,000 pounds needed to bring the nutrient concentration to nuisance-potential levels would accumulate in this area.

Growing alewives concentrate phosphorus already present in the lake. It is normal for phosphorus to be recycled upon their death, but because of their unusually high population and habit of dying during a short period of the year in the alongshore waters, the phosphorus is released in a relatively small volume of water. It is concluded that phosphate released from decomposing alewives in the alongshore water mass of Lake Michigan is a significant factor in the production of algae. Nuisances which can develop with increases in algal populations include a reduction in transparency, reduction in length of filter runs at water plants, possible taste and odor problems in drinking water, interference with swimming, and deposition of filamentous algae on beaches.

CHAPTER V
Part 2

INVESTIGATION OF NUISANCE ALGAE CONDITIONS ALONG LAKE MICHIGAN SHORELINE

In early August of 1966 the Water Resources Commission received complaints indicating that several Lake Michigan beaches around Muskegon and Grand Haven had unusually high concentrations of algae in the inshore waters. The subsequent Water Resources Commission survey (Appendix K) showed that approximately 32 miles of Lake Michigan shoreline had nuisance accumulations of *Spirogyra* and *Cladophora* in August of 1966. This problem was first observed 6.5 miles south of Muskegon at Norton Township Park and extended intermittently to Benona, 25 miles north of Muskegon. At some beaches in this area the accumulations were not sufficient to cause nuisance conditions.

Sixty miles of shoreline from South Haven to Pentwater (excluding the area described in the above paragraph) had noticeable accumulations of *Cladophora* but little or no *Spirogyra*. In most areas the *Cladophora* was lying on the bottom in windrows and was not as objectionable as was the *Spirogyra* in suspension. Personnel in charge of these beaches voiced only moderate complaints concerning the necessity to rake up the algae once a week or so. In the area where *Spirogyra* was a problem, park managers received complaints of green-stained bathing suits and conditions unfit for swimming. The presence of *Spirogyra* could not be traced to the tributaries since it was not found in any of the river samples.

Based on algal species composition of the 8 areas studied, Holland and Manistee could be described as being the least indicative of enrichment. Populations found at Benona, Muskegon and St. Joseph were the most indicative of enrichment. There were striking differences in the quantity and quality in the inshore phytoplankton and that found beyond 600 feet. Benona is the best example of this where the inshore plankton was dominated by eutrophic species of oligotrophic waters. This suggests that during the summer of 1966 the water masses inshore and offshore from 600 feet out remained separate for long enough periods to support radically different algal populations.

On the basis of this short-term survey there is an apparent relationship between the areas in which nuisance algae occur along the Michigan coastline of Lake Michigan and the proximity of sources of plant nutrients contributed via major tributaries draining urban and agricultural areas. Assuming future weather and current patterns similar to those experienced in 1966, coupled with continued contributions of present water quality from tributary streams and the existing water quality of Lake Michigan we may expect reoccurrences of nuisance algae conditions.

CHAPTER V
Part 3

BACTERIOLOGICAL MONITORING OF WATERS ALONG LAKE MICHIGAN SHORELINE

The Michigan Water Resources Commission maintains an annual summer sampling program of Michigan's Great Lakes coastline surface waters. Bacteriological data presented in Appendix L were obtained in 1966 and 1967. Only the minimum, maximum, and geometric mean values for each sampling location are expressed in this report (Appendix L, Table 1, Figure 1) however results for all samples collected and referred to are on file in the Lansing office of the Water Resources Commission.

Of the 47 locations in the Lower Peninsula for which there is 1966 and 1967 data available, 36 had geometric mean values over 1,000 organisms per 100 ml in 1967, while in 1966 there were only 4 such locations (Appendix L, Figure 1). In 1967 the total number of sampling locations in the Lower Peninsula was expanded to 69 and of these 49 had geometric mean values over 1,000 organisms per 100 ml.

The 1967 data when examined in detail reveals a definite rise to peak coliform concentrations and then a decline for each location during the sampling period of June through August. In the extreme southern Lower Peninsula locations, the peak concentrations occurred in the latter half of June whereas in the northern portion of the Lower Peninsula they appeared in early August. Peak concentrations for locations between these 2 areas followed a gradual time progression from south to north within these limits.

Studies have shown that dead and decaying alewives contribute coliform organisms to the surrounding waters and apparently provide a suitable nutrient enriched environment for bacterial growth and propagation. The bacteriological peaks coincide with the time of appearance of large concentrations of dead alewives. The highest alewife concentrations occurred in the area from St. Joseph to Frankfort (Appendix L, Map 1).

The few sampling locations which did not follow this pattern are located in the northern portion of the Lower Peninsula above Frankfort where lower concentrations of dead alewives were observed and where industrial waste discharges from fruit canning operations contribute coliform to surface waters in the Traverse City area.

From this information, a correlation appears to exist between the high total coliform concentrations and the elevated alewife mortality of 1967. Therefore, until the alewife situation is corrected the assessment of the safety of these waters for full body contact requires the utilization of the sanitary survey and data other than that obtained during the alewife die-off. All of the public beaches in Michigan along the Lake Michigan shoreline are considered to be of satisfactory sanitary quality for full body contact.

Data from the Upper Peninsula's portion of Lake Michigan's coastline is limited at this time. However, a tabulation of the available data has been included in Appendix L, Table 2.

CHAPTER V
Part 4

BIOLOGICAL AND WATER QUALITY INVESTIGATIONS IN THE VICINITY OF THE E. I. DU PONT DISCHARGE TO LAKE MICHIGAN NEAR MONTAGUE

Four investigations of water quality and aquatic fauna have been conducted since 1957 in the immediate vicinity of the E. I. duPont submarine discharge to Lake Michigan at Montague. The most recent investigation took place in September 1967 (Appendix M).

The studies of the bottom animals have not demonstrated any apparent injury even in the immediate vicinity of the outfall. Scuds and midges have been the dominant animals. Minnows and alewives have been observed swimming normally in the discharge as it bubbles to the surface. The bottom material is fine, clean sand with no deposit.

Water samples taken directly over the discharge in September 1967 contained 0.65 mg/l ammonia. No ammonia was detected 100 feet in any direction from the discharge. Other water quality parameters showed little variation at all sampling locations.

CHAPTER V
Part 5

RECONNAISSANCE SURVEY IN THE VICINITY OF THE DOW CHEMICAL COMPANY BRINE DISCHARGE TO LAKE MICHIGAN NEAR LUDINGTON

On August 10, 1967, a reconnaissance survey of the water quality and benthic macroinvertebrate populations was conducted in Lake Michigan in the vicinity of the Dow Chemical Company discharge near Big Sable Point (Appendix N).

The discharge containing waste brines moved north with the alongshore current in the valley between the third and fourth sand bars. Conductivity remained very high, 40,000 micromhos, as far as 1/2 mile northeast. At this point the brine mass commenced to become significantly diluted and lost its identify, although traces could be detected 2 1/2 miles distant.

Several bottom samples were visually examined in the field to judge roughly if the brine mass was grossly affecting the benthic fauna. Five samples were analyzed in the laboratory. Conclusions were that the benthic fauna in the immediate vicinity of the discharge was virtually eliminated, but that the effect was local. Populations commenced recovering 100 feet from the discharge and returned to near normal within 200 yards, depending on direction from discharge point.

Rough water prevented detailed sampling at this time. Further investigations are scheduled to more clearly identify the affected area.

CHAPTER V
Part 6

BIOLOGICAL INVESTIGATIONS IN THE VICINITY OF THE PACKAGING CORPORATION OF AMERICA'S DISCHARGE TO LAKE MICHIGAN NEAR MANISTEE

Macroinvertebrate surveys of the Lake Michigan bottom in the vicinity of Packaging Corporation of America (PCA) discharge have been made in 1957 before the operation started, in 1958, and in 1962. The bottom animal populations in the vicinity of the discharge were indicative of a clean water environment. However, the effluent tended to "float" to the lake surface and complaints of undesirable odors and unnatural colors increased. In 1966 PCA added brine from the discharge of a nearby chemical company to their effluent. Effectively preventing the undesirable "floating".

Investigation in 1967 (Appendix O) revealed chloride concentration on the lake bottom at the discharge was 248 mg/l. The effluent was apparently flowing offshore at this time as concentrations of 130 mg/l were found 4,000 and 8,000 feet west northwest. Alongshore parallel to the discharge concentrations were generally less than 20 mg/l.

No objectionable bottom deposits could be found in the vicinity of the PCA discharge during any of the surveys. The bottom animal populations sampled a mile north and south of the discharge were typical of a clean water environment. Species diversity of the bottom fauna community was lower in the discharge zone, 3.5 species/square foot, than in the zones to the north and south, 6 species/square foot.

CHAPTER V
Part 7

AQUATIC BIOTA INVESTIGATIONS IN THE VICINITY OF THE BIG ROCK POINT NUCLEAR REACTOR

Beginning in 1960, collections (usually biannual) of aquatic plants and animals have been made in the vicinity of the Big Rock Point Reactor for radiological analysis. Background radiation levels (gross beta) were established prior to September 1962 when the Big Rock Point Reactor went critical.

Plankton, filamentous algae, periphyton, crayfish, and minnows have been collected from the Lake Michigan shore zone in the vicinity of the cooling water discharge and at 2 control stations, one 3 miles east and the other 3 miles west of the reactor. The radioactivity of plankton has not varied between these stations on a given date. The seasonal and annual changes noted are apparently related to fallout and natural background.

However, since going critical, radioactivity counts of other biota collected in the Big Rock Point vicinity have been generally higher than at the 2 control stations. During this period background radiation levels throughout the state have been decreasing. Although levels in the Big Rock Point biota are higher than the biota controls, they are similar in magnitude to the levels found before criticality (Appendix P).

CHAPTER V
Part 8

OTHER TRIBUTARY AND LAKE MICHIGAN MONITORING PROGRAMS

Water quality monitoring of Great Lakes tributary streams was initiated by the Water Resources Commission in May of 1955 to obtain background radioactivity information. In 1963, the program was expanded to include a variety of water quality data. The specific objectives of this program were to determine long-term trends in the chemical, physical and bacteriological characteristics of tributary streams to the Great Lakes in Michigan's Lower Peninsula.

Initially 1 sampling station was established on each of 28 drainage basins in the Lower Peninsula, 12 of which are located on tributaries discharging to Lake Michigan. This provided coverage of all the major basins as well as those known to be receiving significant discharges of industrial or domestic wastes. The 12 tributary basins contain approximately 63% of Michigan's total land area in the Michigan basin and discharge approximately 60% of the total flow contributed to Lake Michigan from Michigan tributaries. Approximately 87% of the total population in the Michigan portion of the Lake Michigan Basin reside in the monitored basins.

The monitoring stations (Appendix Q, Table 1) are located as close as possible to the mouths of the basins and, with 1 exception, below all known sources of waste. The exception is the station on the Kalamazoo River near Saugatuck where the effluent from the Saugatuck sewage treatment plant discharges downstream from the sampling point. In this instance, the volume of effluent is small in relation to volume of river flow and sampling below the outfall was not justified due to difficulty of collection.

Samples are collected every 2 weeks and analyzed by the Commission's laboratory in Lansing. The collection, storage, preservation and analyses of all samples are in accordance with methods and procedures prescribed by Standard Methods for the Examination of Water and Wastewater, Twelfth Edition.

A summary of data collected for this program in 1965 and 1966 is presented in Tables 2, 3 and Figure 1 of Appendix Q. The monitored tributaries and their drainage areas are shown on Map 1. In addition, the data from individual stations for selected parameters has been graphically presented in Figures 2 through 13 for the years 1965 and 1966, illustrating any seasonal or short-term fluctuations in water quality.

In addition to the regular monitoring of Lake Michigan tributaries, the Commission staff has inaugurated a program of sampling of raw water from Lake Michigan. This is done at various water treatment plants around the perimeter of the lake. The intent of the program is to establish exisitng water quality at the various intakes and indicate any trends which occur in the quality.

The samples are collected prior to any treatment by the plants and are handled in the manner described for tributary samples. These samples are currently collected annually. The first series was collected in 1967 and the results are shown in Table 4 of Appendix Q. Sampling locations are outlined on Map 2.

In addition to the program conducted by the Water Resources Commission the Michigan Department of Public Health requires that each water treatment plant submit monthly operating reports which contain results of physical, chemical and bacteriological tests which are made on the raw water supply. Data submitted in 1966 is summarized in Table 5 of Appendix O. The 2 programs supplement each other and furnish fairly complete documentation of water quality at water intakes in Lake Michigan.

The staff of the Water Resources Commission conducts various surveys throughout the state in accordance with its programs of pollution prevention and abatement. Table 6, Appendix O, contains data from several such surveys which were conducted in the Lake Michigan Basin. The stations shown on Map 3 are ones which were located closest to Lake Michigan (most downstream) and are indicative of tributary water quality at the time of the surveys. This information is presented to cover areas of the basin not included under long-range monitoring. Samples in some cases were collected over 24-hour periods while others were single grab samples.

Routine sampling of the state's surface waters for obtaining background radioactivity data was initiated in 1955 with the establishment of 4 sampling stations on 2 eastern Michigan streams. In 1956 the number of stations was increased to 11, of which 8 were on 5 different streams and 3 were at municipal water supply intakes on the Great Lakes.

In 1958 the number of sampling stations was increased to 26, in 1960 the sampling network was expanded to 31 stations and in 1963 to 38. These include 13 stations on Great Lakes waters and 25 on interior rivers or streams. Twelve stations are at municipal water supply intakes. Map 4, Appendix O, locates the sampling stations.

The data obtained by this program is published yearly as part of the report, "State of Michigan, Water Quality Monitoring Program, Water Quality Records", and is available in the files of the Water Resources Commission

Five water quality parameters were selected as being indicative of the chemical water quality of the Lake Michigan tributaries; dissolved oxygen, biochemical oxygen demand, chlorides, phosphates, and nitrate nitrogen. Table 2, Appendix Q, is a summary of these 5 parameters by river basin.

Dissolved Oxygen

The 2-year average of the DO values for the monitored streams ranges from 8.6 mg/l to 11.4 mg/l. The lowest recorded single value was 6.0 mg/l which was found in the Pine River at Charlevoix and the Kalamazoo River at Saugatuck. The Kalamazoo exhibits the lowest 2-year average while the Pine and the St. Joseph rivers exhibit the highest 2-year averages.

The individual Figures 2-13, Appendix O, illustrate the seasonal variations which occur in the DO levels, with the higher values present in the winter months and the lower values found in late summer and early fall.

Biochemical Oxygen Demand

The 2-year averages of BOD values range from a low of 1.7 mg/l in the Manistee River to a high of 5.5 mg/l in the Grand River. Only 3 of the rivers, the St. Joseph, the Grand, and the Kalamazoo have BOD's above 3.0 mg/l.

The individual graphs illustrate fairly steady BOD values throughout the 2-year period with little indication of seasonal or other trends.

Chlorides

The 2-year averages of chloride values range from a low of 3 mg/l in the Boardman River at Traverse City to a high of 71 mg/l in the Manistee River at Manistee. Three rivers have values below 10 mg/l as an average.

The individual graphs indicate no particular trend through the 2-year period.

Phosphates - PO_4

The 2-year averages of phosphate values range from a low of 0.008 mg/l in the Manistee River to a high of 0.57 mg/l in the Black River at South Haven. In general the higher values are found in the southern part of the state which is the most densely populated with the exception of the Boardman River at Traverse City which exhibits a high value.

The individual graphs indicate a seasonal trend in phosphate values with the high readings occurring in the winter months.

To find the total amount of phosphorus (P) being contributed to Lake Michigan from Michigan tributaries, calculations were made using drainage area and flow data from U. S. Geological Survey records and PO_4 data from the tributary monitoring program. From the calculations (Appendix B), the estimated annual average amount of total phosphorus (P) discharged is 2,700,000 pounds per 1,350 tons.

Nitrate Nitrogen NO_3-N

The 2-year averages of nitrogen values range from a low of 0.188 mg/l in the White River to a high of 1.029 mg/l in the Grand River. The highest values are again found in the southern part of the state.

The individual graphs indicate a seasonal fluctuation in nitrogen values with high readings in the winter months and low readings during the summer.

CHAPTER V
Part 9

VESSEL POLLUTION - OIL AND RUBBISH

The number of incidents of oil pollution from vessels engaged in commercial navigation reported to the Water Resources Commission has increased markedly in recent years. These incidents have ranged from the most serious--a sinking of an oil barge on the Lake Michigan coast, and the subsequent massive fouling of stretches of beaches for over 200 miles; to the nearly continuous summertime complaints of swimmers smeared by heavy fuel oils.

The increasing number of complaints has, in general, corresponded with the increase of vessels on the Great Lakes using oil as fuel. These have been vessels solely engaged in lake commerce as well as the growing number of vessels engaged in ocean commerce. Nearly all vessels inbound into the Great Lakes via the St. Lawrence Seaway use oil as fuel.

An attendant problem associated with Great Lakes commercial navigation is the indiscriminate overboard disposal of garbage, dunnage, and trash. The effects of this problem grow increasingly worse with the use of plastics and other non-destructible containers. There is an increasing public and private cost in the removal of this debris from Great Lakes beaches. The aesthetic damage is even more serious.

CHAPTER VI

CONCLUSIONS

The citizens and government of Michigan are very keenly aware of the value of clean water, both in Lake Michigan and in inland lakes and streams. The people have supported, and State government has developed, broad-scale and fast moving programs of pollution control.

Michigan law provides a full and effective statutory basis for preventing and controlling pollution. The State Legislature has repeatedly shown its willingness to enact additional laws as the need for them emerges.

Through its Water Resources Commission, its Department of Public Health and its Geological Survey, Michigan has an aggressive, effective and large-scale program of water pollution control in active operation. The Michigan plan for effectuating this program in 1967-68 has been fully approved by the Secretary of the Interior.

The State has an ongoing and appropriately expanding program of waste disposal surveillance and water quality monitoring which is fully responsive to the needs for detecting and identifying its pollution problems.

The Water Resources Commission and Department of Public Health have amply demonstrated that when pollution problems are identified they can and do take proper corrective action.

The State Legislature has responded generously to Executive requests for successive increases in State expenditures for pollution control.

The Water Resources Commission has adopted water quality standards for all waters together with a plan for implementation and enforcement of the interstate waters within a time period that is fully consistent with the objectives set forth in the Federal report, "Water Pollution Problems of Lake Michigan and Tributaries".

The Michigan agencies recognize the pollution problems on waters tributary to Lake Michigan and have in operation aggressive programs for their full and timely correction. The present deficiencies in waste treatment at inland locations do not contribute to pollutional conditions in Lake Michigan except as a residual phosphate loading carries on down to the lake.

The Water Resources Commission recognizes the phosphate problem in accelerating stream and lake water enrichment, and has adopted a state-wide policy and comprehensive program for phosphate removal from waste discharges, with scheduled early completion dates.

The recently accelerating algae problem in Lake Michigan along its Michigan shore appears to derive significantly from phosphate concentrations in alewives and its deposition in near-shore waters from the decomposition of these fish following their increasingly massive seasonal die-off. The control of alewife populations appears to be an essential element of algae control.

Oxygen deficiency problems in the Michigan waters of Lake Michigan are not disclosed by data collected by the Michigan Water Resources Commission. The absence of such problems is substantiated by findings of the U. S. Department of Health, Education and Welfare's Public Health Service studies under the Great Lakes-Illinois River Basin's Project.

These findings, which were cited by Special Master Albert E. Maris in his report to the U. S. Supreme Court on the Chicago diversion litigation among the lake states, further show no open-lake pollutional concentrations of ammonia nitrogen, nitrate nitrogen, phosphates, ABS, toxic metals, or other physical parameters.

No Lake Michigan bathing beaches in Michigan have been closed or considered for closing due to water pollution. Bacteria counts at all such beaches, attributable to human sewage, are well within the limits recommended in the Federal report for this conference.

The discharge of sewage, garbage, trash and oils from interstate carriers, and the loss of oils and other pollutional cargo from such carriers resulting from shipwrecks, are of deep concern to the people and government of Michigan because of their serious injury and threat of injury to recreational water use. Early and full answers are needed as to where the responsibility lies for coping with this problem, as is the establishment of procedures for effective enforcement and for the prompt effectuation of emergency measures to prevent and control accidental pollutional losses from such carriers.

The implementation of Michigan's plan and achievement of the improvements in water quality in Lake Michigan will be greatly enhanced by the earliest possible approval of the Michigan standards by the Secretary of the Interior.

Accomplishment of the Michigan pollution control program is dependent largely upon the availability of funds to build the necessary municipal waste treatment facilities. Full funding of the Federal grants authorized for this purpose in the Clean Waters Restoration Act of 1966 is urgently necessary. A massive state bonding proposal providing for full state partnership in financing has been recommended by Governor Romney to the 1968 Legislature.

APPENDIX A

Act 245, Public Acts of 1929, as amended

State of Michigan

WATER RESOURCES COMMISSION

Act 245, Public Acts of 1929, as amended *

An act to create a water resources commission to protect and conserve the water resources of the state, to have control over the pollution of any waters of the state and the great lakes, with power to make rules and regulations governing the same, and to prescribe the powers and duties of such commission; to prohibit the pollution of any waters of the state and the great lakes; to designate the commission as the state agency to cooperate and negotiate with other governments and agencies in matters concerning the water resources of the state; and to provide penalties for the violation of this act.

Sec. 1. For the purpose of carrying out the provisions of this act there is hereby created a water resources commission, hereinafter referred to as the commission, which shall consist of the director of conservation, the commissioner of health, the highway commissioner, the director of agriculture, and 3 citizens of the state to be appointed by the governor, by and with the advice and consent of the senate, 1 from groups representative of industrial management, 1 from groups representative of municipalities, and 1 from groups representative of conservation associations or interests, for terms of 3 years each except that of the members first appointed, 1 shall be appointed for a term of 1 year, 1 for a term of 2 years, and 1 for a term of 3 years. Vacancies shall be filled for the unexpired term in the same manner as original appointments. Members of the commission shall be entitled to actual and necessary expenses incurred in the performance of official duties. It shall be the duty of the department of administration to provide suitable office facilities for the use of the commission.

Each of the aforesaid state officers is hereby authorized to designate a representative from his department to serve in his stead as a member of the commission for 1 or more meetings.

Sec. 2. The commission shall organize and make its own rules and regulations and procedure and shall meet at least once each month and shall keep a record of its proceedings. The commission shall protect and conserve the water resources of the state and shall have control of the pollution of surface or underground waters of the state of Michigan and the great lakes, which are or may be affected by waste disposal of municipalities, industries, public or private corporations, individuals, partnership associations, or any other entity. The commission is empowered to make or cause to be made surveys, studies and investigations of the uses of waters of the state, both surface and underground, and to cooperate with other governments, governmental units and agencies thereof in making such surveys, studies and investigations. The commission shall assist in an advisory capacity any flood control district which may be authorized by the legislature of this state. The commission in the public interest shall have the right and duty to appear and present evidence, reports and other testimony during the hearings involving the creation and organization of flood control districts. It shall also be the duty and responsibility of the commission to advise and consult with the legislature on the obligation of the state to participate in the costs of construction and maintenance as provided for in the official plans of any flood control district or intercounty drainage district. The commission shall have authority to, and shall enforce the provisions of this act and shall make and promulgate such rules and regulations as shall be deemed necessary to carry out the provisions of this act. The rules and regulations of the commission shall be promulgated in conformity with the provisions of Act No. 88 of the Public Acts of 1943, as amended, being sections 24.71 to 24.82, inclusive, of the Compiled Laws of 1948.

Sec. 2a. The water resources commission is hereby designated the state agency to cooperate and negotiate with other governments, governmental units and agencies thereof in matters concerning the water resources of the state, including but not limited to flood control and beach erosion control. The commission is further authorized to take such steps as may be

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* Amended by Act 117, P.A. 1949, effective May 18, 1949; Act 165, P.A. 1963, effective September 6, 1963; and Act 405, P.A. 1965, effective October 29, 1965.

necessary to take advantage of any act of congress heretofore or hereafter enacted which may be of assistance in carrying out the purposes of this act.

The commission shall report to the governor and to the legislature at least once in each year any plans or projects being carried on or considered and shall include in such report requests for any legislation needed to carry out any proposed projects or agreements made necessary thereby, together with any requests for appropriations.

Sec. 3. The commission shall be authorized to bring any appropriate action in the name of the people of the state of Michigan, either at law or in chancery as may be necessary to carry out the provisions of this act, and to enforce any and all laws relating to the pollution of the waters of this state. Whenever the attorney general deems it necessary, he shall take charge of and prosecute all criminal cases arising under the provisions of this act.

Sec. 4. The commission or any agent duly appointed by it shall have the right to enter at all reasonable times in or upon any private or public property for the purpose of inspecting and investigating conditions relating to the pollution of any waters of this state. The commission shall have the right to call upon any officer, board, department school, university or other state institution and the officers or employees thereof for any assistance deemed necessary to the carrying out of this act.

Sec. 5. The commission shall establish such pollution standards for lakes, rivers, streams and other waters of the state in relation to the public use to which they are or may be put, as it shall deem necessary. It shall have the authority to ascertain and determine for record and in making its order what volume of water actually flows in all streams, and the high and low water marks of lakes and other waters of the state, affected by the waste disposal or pollution of municipalities, industries, public and private corporations, individuals, partnership associations, or any other entity. It shall have authority to make regulations and orders restricting the polluting content of any waste material or polluting substance discharged or sought to be discharged into any lake, river, stream, or other waters of the state. It shall have the authority to take all appropriate steps to prevent any pollution which is deemed by the commission to be unreasonable and against public interest in view of the existing conditions in any lake, river, stream, or other waters of the state.

Sec. 6. (a) It shall be unlawful for any person directly or indirectly to discharge into the waters of the state any substance which is or may become injurious to the public health, safety or welfare; or which is or may become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being or may be made of such waters; or which is or may become injurious to the value or utility of riparian lands; or which is or may become injurious to livestock, wild animals, birds, fish, aquatic life or plants or the growth or propagation thereof be prevented or injuriously affected; or whereby the value of fish and game is or may be destroyed or impaired.

(b) The discharge of any raw sewage of human origin, directly or indirectly into any of the waters of the state shall be considered prima facie evidence of the violation of section 6 (a) of this act unless said discharge shall have been permitted by an order, rule or regulation of the commission. Any city, village or township which permits, allows or suffers the discharge of such raw sewage of human origin into any of the waters of the state by any of its inhabitants or persons occupying lands from which said raw sewage originates, shall be subject only to the remedies provided for in section 7 of this act.

(c) Whenever a court of competent jurisdiction in this state shall have ordered the installation of a sewage disposal system in any township, and the plans therefor shall have been prepared, and approved by the state health commissioner, the township shall have authority to issue and sell the necessary bonds for the construction and installation thereof, including the disposal plant and such intercepting and other sewers as may be necessary to permit the effective operation of such system. Such bonds shall be issued in the same manner as provided for in Act No. 320 of the Public Acts of 1927, being sections 123.241 to 123.253 of the Compiled Laws of 1948, or any other act providing for the issuance of bonds in townships.

(d) Any violation of any provision of section 6 shall be prima facie evidence of the existence of a public nuisance and in addition to the remedies provided for in this act may be abated according to law in an action brought by the attorney general in a court of competent jurisdiction.

Sec. 7. Whenever in the opinion of the commission any person shall violate or is about to violate the provisions of this act, or fails to control the polluting content or substance discharged or to be discharged into any waters of the state, the commission may notify the alleged offender of such determination by the commission. Said notice shall contain in addition to a statement of the specific violation which the commission believes to exist, a proposed form of order or other action which it deems appropriate to assure correction of said problem within a reasonable period of time and shall set a date for a hearing on the facts and proposed action involved, said hearing to be scheduled not less than 4 weeks or more than 8 weeks from the date of said notice of determination. Extensions of the date of hearing may be granted by the commission or on request. At such hearing any interested party may appear, present witnesses and submit evidence. Following such hearing, the final order of determination of the commission upon such matter shall be conclusive, unless reviewed in accordance with the provisions of the administrative procedures of Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948, or any amendment thereto in the circuit court for the county of Ingham, in or for the county in which such person resides, or for the county in which the violation occurred, upon petition therefor filed within 15 days after the service upon said person of the final order of determination.

Sec. 8. (a) Whenever any person shall feel himself aggrieved by the restriction of polluting content, waste or pollution, or any other order of the commission, he shall have a right to file a sworn petition with the commission, setting forth the grounds and reasons for his complaint and asking for a hearing of the matter involved. The commission shall thereupon fix the time and place for such hearing and shall notify the petitioner thereof. At such hearing the petitioner and any other interested party may appear, present witnesses and submit evidence. Following such hearing, the final order of determination of the commission upon such matter shall be conclusive unless reviewed in accordance with the provisions of the administrative procedures of Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948, or any amendment thereto in the circuit court for the county of Ingham, or for the county in which such person resides, or for the county in which the alleged violation occurred.

(b) On and after May 18, 1949, any person requiring a new or substantial increase over and above the present use now made of the waters of the state for sewage or waste disposal purposes shall file with the commission a written statement setting forth the nature of the enterprise or development contemplated, the amount of water required to be used, its source, the proposed point of discharge of the wastes into the waters of the state, the estimated amount so to be discharged, and a fair statement setting forth the expected bacterial, physical, chemical and other known characteristics of the wastes. Within 60 days of receipt of the statement, the commission shall make an order stating such minimum restrictions as in the judgment of the commission may be necessary to guard adequately against such unlawful uses of the waters of the state as are set forth in section 6. If the order is not acceptable to the user, he may request a hearing on the matter involved, following which the commission's final order of determination in this connection shall be conclusive unless reviewed in accordance with the provisions of the administrative procedures of Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948, or any amendment thereto in the circuit court for the county of Ingham, in or for the county in which the user resides, or for the county in which the use is contemplated, upon petition therefor filed within 15 days after service upon said user of the final order of determination.

Sec. 9. Any duly appointed agent of the commission shall have authority to enforce the provisions of this act and may make criminal complaint against any person violating the same. After service of a written notice of determination, setting forth specifically any violation of this act, any person who shall fail to comply with the order of the commission shall be subject to the penalties of this act.

Sec. 10. Any person, except a municipality, who discharges any substance into the waters of the state contrary to the provisions of section 6 or who fails to comply with any restriction, regulation or final order of determination of the commission made under the provisions of this act shall be guilty of a misdemeanor and upon conviction thereof shall be punished by a fine of not less than $500.00 and in the discretion of the court it may impose an additional fine of not less than $500.00 per day for any number of days during which such violation occurred: Provided, however, That such person shall not be subject to the penalties of this section if the discharge of the effluent is in conformance with and obedient to a rule, regulation or order of the commission. In addition to the minimum fine herein specified, the attorney general, at the request of the department of conservation, is authorized to file a suit in any court of competent jurisdiction to recover the full value of the injuries done to the natural resources of the state by such violation.

Sec. 11. Wherever the word "person" is used in this act, it shall be construed to include any municipality, industry, public or private corporation, co-partnership, firm or any other entity whatsoever. Wherever the words "waters of the state" shall be used in this act, they shall be construed to include lakes, rivers and streams and all other water courses and waters within the confines of the state and also the great lakes bordering thereon.

Sec. 12. This act shall not be construed as repealing any of the provisions of the law governing the pollution of lakes and streams, but shall be held and construed as ancillary to and supplementing the same and in addition to the laws now in force, except as the same may be in direct conflict herewith. This act shall not be construed as applying to copper or iron mining operations, whereby such operations result in the placement, removal, use or processing of copper or iron mineral tailings or copper or iron mineral deposits from such operations being placed in inland waters on bottom lands owned by or under the control of the mining company and only water which may contain a minimal amount of residue as determined by the water resources commission resulting from such placement, removal, use or processing being allowed or permitted to escape into public waters; or applying to the discharge of water from underground iron or copper mining operations subject to a determination by the water resources commission.

Sec. 12a. The provisions of this act shall be construed as supplemental to and in addition to the provisions of Act No. 316 of the Public Acts of 1923, as amended, being sections 261.1 to 277.10, inclusive, of the Compiled Laws of 1948; and nothing in this act shall be construed to amend or repeal any law of the state of Michigan relating to the public service commission, the department of conservation and the department of health relating to waters and water structures, or any act or parts of acts not inconsistent with the provisions of this act.

APPENDIX B

CONTROL OF WATERCRAFT POLLUTION

MICHIGAN DEPARTMENT OF CONSERVATION
WATER RESOURCES COMMISSION

PROPOSED RULE FOR THE CONTROL OF WATERCRAFT POLLUTION

By authority conferred on the Water Resources Commission by Sections 2 and 5 of Act 245, Public Acts of 1929, as amended, being CL '48, § 323.2 and § 313.5, the following is hereby promulgated, to go into effect on January 1, 1970.

R 323.AAA.

1. TERMS DEFINED

(a) The term "watercraft" means any contrivance used or capable of being used for navigation upon water whether or not capable of self-propulsion, except passenger or cargo-carrying vessels subject to the Interstate Quarantine Resultions of the United States Public Health Service adopted pursuant to Title 42 United States Code § 241, 243, 252 and 262-272.

(b) The term "sewage" means all human body wastes, treated or untreated.

(c) The term "litter" means any bottles, glass, crockery, cans, scrap metal, junk, paper, garbage, rubbish, or similar refuse discarded as no longer useful or usable.

(d) The term "marine toilet" means any toilet on or within any watercraft.

(e) The term "Commission" means the Water Resources Commission, Department of Conservation.

(f) The term "non-pollutional" means incapable of causing unlawful pollution as defined in Section 6.

2. MARINE TOILETS - RESTRICTIONS AND POLLUTION CONTROL DEVICES

(a) No person shall operate a marine toilet on a watercraft on the waters of the state so as to discharge any sewage into such waters unless such sewage has been rendered non-pollutional by passage through a device which has been approved by the Commission.

(b) No person owning or operating a watercraft having a marine toilet shall use or permit the use of such toilet on the waters of the state unless the toilet is equipped with one of the following pollution control devices:

i. A holding tank which will retain all sewage that is produced on the watercraft, or

ii. An incinerating device which will reduce to ash all sewage that is produced on the watercraft, or

iii. A device which has been determined by the Commission to be capable of rendering the sewage discharges non-pollutional in accordance with the requirements of Act 245, Public Acts of 1929, as amended.

(c) No person shall dispose of sewage accumulated in holding tanks or in any other container on a watercraft in such a manner that the sewage reaches or may reach the waters of the state except through a sewage disposal facility which has the approval of the State Department of Public Health or its designated representative.

R 323.AAB. WATERCRAFT REGISTRATION - MARINE TOILET FACILITIES

Persons when making application for a certificate of number for a watercraft pursuant to § 3, Act 303, Public Acts of 1967, (CL '48, § 281.653) shall disclose at such time to the Commission whether such watercraft has within or on it a marine toilet, and if so, whether such toilet is equipped with one of the pollution control devices as required by this Rule. The Commission may request the Secretary of State to provide it with the name of any applicant whose application indicates the absence of such pollution control device on a marine toilet.

R 323.AAC. DISPOSAL OF LITTER

The disposal of litter shall be subject to the provisions of Act 106 of the Public Acts of Michigan for 1963.

January 29, 1968

APPENDIX C

MICHIGAN'S INTERSTATE WATER QUALITY STANDARDS

COMMISSION OBJECTIVE:

WATERS IN WHICH THE EXISTING QUALITY IS BETTER THAN THE ESTABLISHED STANDARDS AS OF THE DATE SUCH STANDARDS BECOME EFFECTIVE WILL NOT BE LOWERED IN QUALITY BY ACTION OF THE WATER RESOURCES COMMISSION UNLESS AND UNTIL IT HAS BEEN AFFIRMATIVELY DEMONSTRATED THAT THE CHANGE IN QUALITY WILL NOT BECOME INJURIOUS TO THE PUBLIC HEALTH, SAFETY, OR WELFARE, OR BECOME INJURIOUS TO DOMESTIC, COMMERCIAL, INDUSTRIAL, AGRICULTURAL, RECREATIONAL OR OTHER USES WHICH ARE BEING MADE OF SUCH WATERS, OR BECOME INJURIOUS TO THE VALUE OR UTILITY OF RIPARIAN LANDS, OR BECOME INJURIOUS TO LIVESTOCK, WILD ANIMALS, BIRDS, FISH, AQUATIC LIFE OR PLANTS, OR THE GROWTH OR PROPAGATION THEREOF BE PREVENTED OR INJURIOUSLY AFFECTED, OR WHEREBY THE VALUE OF FISH AND GAME MAY BE DESTROYED OR IMPAIRED.

WATER WHICH DOES NOT MEET THE STANDARDS WILL BE IMPROVED IN QUALITY TO MEET THE STANDARDS.

WATER

PARAMETERS WATER USES	1 COLIFORM GROUP (organisms/100ml or MPN)	2 DISSOLVED OXYGEN (mg/l)	3 SUSPENDED, COLLOIDAL & SETTLEABLE MATERIALS	4 RESIDUES (Debris and material of unnatural origin and oils)	5 TOXIC & DELETERIOUS SUBSTANCES
A **WATER SUPPLY** **(1) DOMESTIC** Such as drinking, culinary and food processing.	For Great Lakes & Connecting Waters: The monthly average shall not exceed 2000 nor shall 20% of the samples examined exceed 2000 For Inland Waters: The monthly average shall not exceed 5000 nor shall 20% of the samples examined exceed 5000, nor exceed 20,000 in more than 5% of the samples	Present at all times in sufficient quantities to prevent nuisance	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating Solids: None of unnatural origin Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Conform to current USPHS Drinking Water Standards except: Cyanide: Normally not detectable with a maximum upper limit of 0.2 mg/l Chromium: Normally not detectable with a maximum upper limit of 0.05 mg/l Phenol: Limitations as defined under A-B
(2) INDUSTRIAL Such as cooling and manufacturing process.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Present at all times in sufficient quantities to prevent nuisance	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use
B **RECREATION** **(1) TOTAL BODY CONTACT** Such as swimming, water skiing and skin diving.	The average of any series of 10 consecutive samples shall not exceed 1000 nor shall 20% of the samples examined exceed 5,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 100. See Appendix A, Section B	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use
(2.) PARTIAL BODY CONTACT Such as fishing, hunting, trapping and boating	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000. See Appendix A, Section B	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use
C **FISH, WILDLIFE AND OTHER AQUATIC LIFE** such as (growth and propagation)	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	At the average low river flow of 7-day duration expected to occur once in 10 years the following DO values shall be maintained for: Intolerant fish - cold water species: Not less than 6 at any time Intolerant fish - warm water species: Average daily DO not less than 5, nor shall any single value be less than 4 Tolerant fish - warm water species: Average daily DO not less than 4, nor shall any single value be less than 3 At greater flows the DO shall be in excess of these values.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Not to exceed 1/10 of the 96-hour median tolerance limit obtained from continuous flow bioassays where the dilution water and toxicant are continuously renewed except that other application factors may be used in specific cases when justified on the basis of available evidence and approved by the appropriate agency.
D **AGRICULTURAL** Such as livestock watering, irrigation and spraying.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Not less than 3 at any time	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Conform to current USPHS Drinking Water Standards as related to toxicants. Toxic and deleterious substances shall be less than those which are or may become injurious to the designated use.
E **COMMERCIAL** Such as navigation, hydroelectric and steam generated electric power	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use

QUALITY STANDARDS

TOTAL DISSOLVED SOLIDS (mg/l) 6	NUTRIENTS 7 Phosphorus, ammonia, nitrates and sugars	TASTE & ODOR PRODUCING SUBSTANCES 8	TEMPERATURE* 9 (°F)	HYDROGEN ION 10 (pH)	RADIOACTIVE MATERIALS 11
FOR GREAT LAKES & CONNECTING WATERS: Total Dissolved Solids: The maximum shall not exceed 200 Chlorides: The monthly average shall not exceed 50. A monthly average of 10 is a desirable limit where existing conditions are less than 10. FOR INLAND WATERS: Total Dissolved Solids: Shall not exceed 500 as a monthly average, nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent adverse effects on water treatment processes or the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use. Monthly average phenol concentration less than 0.002 mg/l - maximum concentration limited to 0.005 mg/l for a single sample.	The maximum natural water temperature shall not be increased by more than 10°F	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.
Total Dissolved Solids: Shall not exceed 500 as a monthly average nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	The maximum natural water temperature shall not be increased by more than 10°F	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range	Standards to be established when information becomes available on deleterious effects
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range	Standards to be established when information becomes available on deleterious effects
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range	Standards to be established when information becomes available on deleterious effects
Standards to be established when information becomes available on deleterious effects.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are causing or may cause taint in the flesh of fish or game.	Ambient / Allowable increase / Maximum limit Intolerant fish - cold water species: 32° to nat max. / 10° / 70° Intolerant fish - warm water species: 32° to 35° / 15° 36° to nat max / 10° / 85° Tolerant fish - warm water species: 32° to 59° / 15° 60° to nat max / 10° / 87°	Maintained between 6.5 and 8.8 with a maximum artificially induced variation of 1.0 unit within this range. Changes in the pH of natural waters outside these values must be toward neutrality (7.0.)	Standards to be established when information becomes available on deleterious effects
Less than 700 dissolved minerals. Maximum percentage of sodium 60% as determined by the formula $\frac{(Na \times 100)}{(Na+Ca+Mg+K)}$ when the bases are expressed as milliequivalents per liter.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use. NO_3 concentrations shall conform to USPHS Drinking Water Standards.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	Not applicable	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use	The maximum natural water temperature shall not be increased by more than 10°F	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range	Standards to be established when information becomes available on deleterious effects

* For the Great Lakes and connecting waters no heat load in sufficient quantity to create conditions which are or may become injurious to the public health, safety or welfare, or which are or may become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being or may be made of such waters, or which are or may become injurious to the value or utility of riparian lands, or which are or may become injurious to livestock, wild animals, birds, fish or aquatic life or the growth or propagation thereof.

APPENDIX D

MICHIGAN'S INTRASTATE WATER QUALITY STANDARDS

WATER QUALITY STANDARDS
for
MICHIGAN INTRASTATE WATERS

State of Michigan
Water Resources Commission
Department of Conservation
Adopted January 1968

COMMISSION OBJECTIVE:

WATERS IN WHICH THE EXISTING QUALITY IS BETTER THAN THE ESTABLISHED STANDARDS AS OF THE DATE SUCH STANDARDS BECOME EFFECTIVE WILL NOT BE LOWERED IN QUALITY BY ACTION OF THE WATER RESOURCES COMMISSION UNLESS AND UNTIL IT HAS BEEN AFFIRMATIVELY DEMONSTRATED THAT THE CHANGE IN QUALITY WILL NOT BECOME INJURIOUS TO THE PUBLIC HEALTH, SAFETY, OR WELFARE, OR BECOME INJURIOUS TO DOMESTIC, COMMERCIAL, INDUSTRIAL, AGRICULTURAL, RECREATIONAL OR OTHER USES WHICH ARE BEING MADE OF SUCH WATERS, OR BECOME INJURIOUS TO THE VALUE OR UTILITY OF RIPARIAN LANDS, OR BECOME INJURIOUS TO LIVESTOCK, WILD ANIMALS, BIRDS, FISH, AQUATIC LIFE OR PLANTS, OR THE GROWTH OR PROPAGATION THEREOF BE PREVENTED OR INJURIOUSLY AFFECTED, OR WHEREBY THE VALUE OF FISH AND GAME MAY BE DESTROYED OR IMPAIRED.

WATER WHICH DOES NOT MEET THE STANDARDS WILL BE IMPROVED IN QUALITY TO MEET THE STANDARDS.

WATER

PARAMETERS / WATER USES	1 COLIFORM GROUP (organisms/100ml or MPN)	2 DISSOLVED OXYGEN (mg/l)	3 SUSPENDED, COLLOIDAL & SETTLEABLE MATERIALS	4 RESIDUES (Debris and material of unnatural origin and oils)	5 TOXIC & DELETERIOUS SUBSTANCES
A WATER SUPPLY **(1.) DOMESTIC** Such as drinking, culinary and food processing.	The monthly geometric average shall not exceed 5000 nor shall 20% of the samples examined exceed 5000, nor exceed 20,000 in more than 5% of the samples.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating Solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Conform to current USPHS Drinking Water Standards except: Cyanide: Normally not detectable with a maximum upper limit of 0.2 mg/l Chromium: Normally not detectable with a maximum upper limit of 0.05 mg/l Phenol: Limitations as defined under A-8.
(2.) INDUSTRIAL Such as cooling and manufacturing process.	The geometric average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The fecal coliform geometric average for the same 10 consecutive samples shall not exceed 1000	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use
B RECREATION **(1.) TOTAL BODY CONTACT** Such as swimming, water skiing and skin diving.	The geometric average of any series of 10 consecutive samples shall not exceed 1000 nor shall 20% of the samples examined exceed 5,000. The fecal coliform geometric average for the same 10 consecutive samples shall not exceed 100	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use.
(2.) PARTIAL BODY CONTACT Such as fishing, hunting, trapping and boating.	The geometric average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The fecal coliform geometric average for the same 10 consecutive samples shall not exceed 1000	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use
C FISH, WILDLIFE AND OTHER AQUATIC LIFE such as (growth and propagation)	The geometric average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The fecal coliform geometric average for the same 10 consecutive samples shall not exceed 1000	At the average low flow of 7-day duration expected to occur once in 10 years the following DO values shall be maintained in rivers capable of supporting: Intolerant fish, cold-water species (trout, salmon) - Not less than 6 at any time. Intolerant fish, warm-water species (bass, pike, panfish) - Average daily DO not less than 5, nor shall any single value be less than 4. Tolerant fish (carp, bullheads) - Average daily DO not less than 4, nor shall any single value be less than 3. Principal anadromous fish migrations in warm-water rivers - Not less than 5 during migrations. At greater flows the DO shall be in excess of these values. For lakes see last page.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Not to exceed 1/10 of the 96-hour median tolerance limit obtained from continuous flow bio-assays where the dilution water and toxicant are continuously renewed except that other application factors may be used in specific cases when justified on the basis of available evidence and approved by the appropriate agency.
D AGRICULTURAL Such as livestock watering, irrigation and spraying.	The geometric average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The fecal coliform geometric average for the same 10 consecutive samples shall not exceed 1000	Not less than 3 at any time.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Conform to current USPHS Drinking Water Standards as related to toxicants. Toxic and deleterious substances shall be less than those which are or may become injurious to the designated use
E COMMERCIAL AND OTHER Such as navigation, hydroelectric and steam generated electric power and uses not included elsewhere in these standards.	The geometric average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The fecal coliform geometric average for the same 10 consecutive samples shall not exceed 1000	Average daily not less than 2.5, nor any single value less than 2.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease	Limited to concentrations less than those which are or may become injurious to the designated use.

QUALITY STANDARDS

TOTAL DISSOLVED SOLIDS (mg/l) 6	NUTRIENTS 7 Phosphorus, ammonia, nitrates and sugars	TASTE & ODOR PRODUCING SUBSTANCES 8	TEMPERATURE (°F) 9	HYDROGEN ION (pH) 10	RADIOACTIVE MATERIALS 11
Total Dissolved Solids: Shall not exceed 500 as a monthly average, nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 75, nor shall any single value exceed 175.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent adverse effects on water treatment processes or the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use. Monthly average phenol concentration less than 0.002 mg/l - maximum concentration limited to 0.005 mg/l for a single sample.	The maximum natural water temperature shall not be increased by more than 10°F	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.
Total Dissolved Solids: Shall not exceed 500 as a monthly average nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	The maximum natural water temperature shall not be increased by more than 10°F	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Standards to be established when information becomes available on deleterious effects.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are causing or may cause taint in the flesh of fish or game.	In rivers capable of supporting — Ambient — Allowable increase — Maximum limit Intolerant fish, cold-water species (trout): 32° to nat. max. — 10° — 70° Intolerant fish, warm-water species (bass): 32° to 35° — 15°; 36° to nat. max. — 10° — 85° Tolerant fish, warm-water species (carp): 32° to 59° — 15°; 60° to nat. max. — 10° — 87° For anadromous fish migrations and inland lakes see last page.	Maintained between 6.5 and 8.8 with a maximum artificially induced variation of 1.0 unit within this range. Changes in the pH of natural waters outside these values must be toward neutrality (7.0).	Standards to be established when information becomes available on deleterious effects.
Less than 700 dissolved minerals. Maximum percentage of sodium 40% as determined by the formula $\frac{(Na \times 100)}{(Na+Ca+Mg+K)}$ when the bases are expressed as milliequivalents per liter.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use. NO_3 concentrations shall conform to USPHS Drinking Water Standards.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	Not applicable	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	The maximum natural water temperature shall not be increased by more than 10°F	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.

C. Fish, wildlife and other aquatic life.

These additional water quality standards for **DISSOLVED OXYGEN** apply to inland lakes naturally capable of supporting:

Intolerant fish, cold-water species (trout, whitefish, cisco)

a. In warm-water lakes with little water exchange which are capable of sustaining cool stratum of well-oxygenated water throughout the summer (above a hypolimnion with very little oxygen): maintain more than 6 mg/l of dissolved oxygen throughout the epilimnion and the upper one-third of the thermocline during the entire summer stagnation period. At all other times the dissolved oxygen concentration must be maintained at natural levels except in prescribed mixing zones.

b. In lakes capable of sustaining high oxygen values throughout the hypolimnion during periods of stagnation: maintain dissolved oxygen values greater than 6 mg/l throughout the entire lake.

c. In lakes which serve as principal anadromous fish migration routes: maintain more than 5 mg/l of dissolved oxygen throughout the epilimnion and the upper one-third of the thermocline in stratified lakes during periods of migration. In unstratified lakes maintain more than 5 mg/l of dissolved oxygen throughout the entire lake during periods of migration.

d. In shallow, unstratified cold-water lakes: maintain dissolved oxygen greater than 6 mg/l throughout the entire lake.

Intolerant fish, warm-water species (bass, pike, panfish)

a. In warm-water lakes with little water exchange: maintain dissolved oxygen values greater than 5 mg/l throughout the epilimnion and the upper one-third of the thermocline during the entire summer stagnation period. At all other times the dissolved oxygen concentration must be maintained at natural levels except in a prescribed mixing zone.

b. In warm-water lakes with a high rate of water exchange: maintain oxygen values greater than 5 mg/l throughout the epilimnion and the upper one-third of the thermocline during the entire summer stagnation period. At all other times the dissolved oxygen concentration must be maintained at more than 5 mg/l except in areas where natural oxygen depressions occur.

These additional water quality standards for **TEMPERATURE** apply to inland lakes naturally capable of supporting:

Intolerant fish, cold-water species (trout, whitefish, cisco)

a. Small warm-water lakes with little water exchange which are capable of supporting trout in the thermocline or hypolimnion and shallow, unstratified cold-water lakes shall not be artificially warmed.

b. Large warm-water lakes with little water exchange which are capable of supporting trout in the thermocline or hypolimnion shall not receive a heat load which would warm the thermocline or hypolimnion. Surface waters may be warmed 10°F when ambient temperature is less than 45°F and 5°F when ambient temperature is greater than 45°F. Maximum limit is 85°F.

c. In lakes which serve as principal anadromous fish migration routes the temperature of the epilimnion shall not be elevated more than 5°F above ambient during the times of migration, and shall, in no instance, interfere with migration. If ambient water temperatures in the migratory channels during the times of migration exceed 65°F they may not be artificially increased to greater than 70°F.

Intolerant fish, warm-water species (bass, pike, panfish)

In warm-water lakes incapable of supporting trout: surface waters may be warmed 10°F when ambient temperature is less than 45°F and 5°F when ambient temperature is greater than 45°F. Maximum limit is 85°F.

Anadromous fish migrations

Warm-water rivers that serve as principal migratory channels for anadromous fish species and that have ambient water temperatures in excess of 65°F during the times of migration may not be artificially warmed to greater than 70°F. At other times of the year the standards for intolerant fish, warm-water species in rivers apply.

APPENDIX E

CHLORINATION POLICY

2698

STATE OF MICHIGAN
DEPARTMENT OF PUBLIC HEALTH
3500 N. LOGAN, LANSING, MICHIGAN 48914

GEORGE ROMNEY, Governor
ALBERT E. HEUSTIS, M.D., Director

January 4, 1967

DEPARTMENT LETTER NO. 35-1

TO: Municipalities Operating Sewage Treatment Plants
Bureau Chiefs
Division Chiefs
Directors of Full-Time Local Health Departments

FROM: John E. Vogt, Chief
Division of Engineering

SUBJECT: Disinfection of Sewage Treatment Plant Effluents

For many years most communities and others operating sewage treatment plants have chlorinated their treated wastewaters before discharging them into our streams and lakes. This practice has provided a large measure of protection of the public health. Present trends in public need for higher water quality to permit increased use of our public waters for all forms of aquatic recreation and other uses involving intimate human contact require refinements in present practices for bacteriological control of treated sewage effluents and greater vigilance by those responsible for the operation of the facilities involved. Greater concentrations of people living close to lakes and streams coupled with year-round recreation including fishing in late fall, winter and early spring requires continuous bacteriological control whenever sewage is discharged to the public waters. Seasonal chlorination during the summer recreation season no longer can be depended upon to provide a full measure of protection to the public health.

It therefore is the declared and established policy that:

> All municipalities and others discharging treated sewage from sewage treatment plants to the public waters of the state be required to provide effective bacteriological control over the effluent therefrom by the continuous application each day of the year of chlorine or other effective chemicals in facilities approved by the State Department of Public Health. Effective control requires sufficient testing at approved points of sample collection to assure the maintenance of an adequate residual of chlorine or other disinfecting agents, supplemented by occasional tests for organisms of the coliform group. Adequate disinfection should reduce consistently the concentration of coliform organisms to 1000 or less per 100 ml.

Approved: Albert E. Heustis, M.D.

John E. Vogt

MICHIGAN
WATER-WINTER WONDERLAND

APPENDIX F

STUDIES ON REMOVAL OF PHOSPHATES
AT
GRAYLING, MICHIGAN

STUDIES ON REMOVAL OF PHOSPHATES
AND
RELATED REMOVAL OF SUSPENDED MATTER AND BIOCHEMICAL OXYGEN DEMAND
AT
GRAYLING, MICHIGAN

MARCH - SEPTEMBER 1967

CONDUCTED BY:

OTTO GREEN, FRED EYER, AND DONALD PIERCE
DIVISION OF ENGINEERING
MICHIGAN DEPARTMENT OF PUBLIC HEALTH

AND

THE DOW CHEMICAL COMPANY

INTRODUCTION

Grayling is a community of 2,000 located on the Au Sable River, a famous trout stream which is probably enjoyed by more people than any other Michigan river. Grayling's wastewater treatment plant, which has been in operation since 1938 and was recently expanded in 1964, has facilities for primary sedimentation and chlorination. Present river studies have shown a deterioration of water quality downstream from the plant. There is an indication of excessive algal and slime growths and higher than normal bacteria counts. It is the concensus that a higher degree of treatment, of which nutrient removal is an essential part, would improve this situation and help preserve one of Michigan's great natural resources.

Preliminary studies on phosphate removal using ferrous chloride and polymers by the Dow Chemical Company at the Midland municipal wastewater treatment plant showed promise of very substantial reduction of total phosphates and suspended solids by application of the chemicals to raw sewage followed by sedimentation. Agreement was reached with the Dow Chemical Company and the City of Grayling that a study would be undertaken at Grayling utilizing the principles and procedures developed at Midland and adapting them to their particular waste characteristics and physical facilities.

The initial bench studies conducted in late March and early April 1967, indicated that Grayling sewage responded to chemical treatment in a fashion quite similar to the Midland experience. These studies were made cooperatively by personnel of the Department of Public Health and Dow's Technical Service and Development Section. Upon review of the bench scale work with the City Manager and the Council of Grayling, it was decided to proceed with plant scale studies. The City's consulting engineers were instructed to install temporary facilities for minor modification of the sedimentation tanks and, with Dow's assistance, install chemical feeding and mixing equipment. This work was performed by the engineers, Dow staff, and Grayling personnel.

The plant scale studies were performed by personnel of the Department of Public Health, the Dow Chemical Company and the Superintendent of the Grayling plant in various combinations. These studies were commenced in mid-June and terminated in mid-September. During most of this period, the plant loadings were usually high by reason of tourist influx in the area and the encampment of troups of the National Guard where facilities are connected to the Grayling sewer system.

PURPOSE OF STUDY

To conduct a cooperative study with the Dow Chemical Company to ascertain the amenability of Grayling waste water to treatment utilizing various forms of iron in conjunction with ionic polymers for removal of phosphates, and related higher removal of suspended matter and biochemical oxygen demand, by both bench scale work and actual plant operation.

DESCRIPTION OF PLANT FACILITIES

The Grayling wastewater treatment facilities consist of the following:

1. A sewage lift station located approximately 600 feet upstream from the plant. The station contains a grit chamber with a bar screen, grit removal facilities, and a comminutor. There are 3 centrifugal pumps: one - 250 gpm, one - 300 gpm, and one - 500 gpm. These pumps are float operated by level variations in the water surface of the wet well. Normally, chlorine is applied in the wet well for odor control during the summer months but was not utilized during the period of this study.

2. Approximately 600 feet of 8-inch force main from the lift station to the treatment plant.

3. A flow splitting chamber which divides the flow delivered in the force main equally among the primary sedimentation tanks.

4. Three primary sedimentation tanks, each 26 feet by 8 feet, with an average water depth of 8 feet, equipped with mechanical sludge and scum removal equipment.

Detention times and overflow rates for various combinations of pumps are as follows:

Pumping Rates GPM	Surface Overflow Rates Gals / sq. ft. / day	Detention Hours
250	577	2.5
250 + 300	1,270	1.1
250 + 300 + 500	2,430	0.6

5. One sludge digestion tank of 4,012 cubic feet capacity which was not in use during the test period. All sludge was pumped to a tank truck and disposed of at the City's sanitary land fill.

6. Chlorination facilities consisting of 1 chlorinator with a maximum feed rate of 40 pounds per day and a chlorine contact of 695 cubic feet volume. This tank is baffled to produce an end around flow. Contact period at 250 gpm pumping rate is 20.8 minutes.

7. The laboratory is fully equipped to conduct a program of wastewater analysis; i.e., solids analysis, BOD determinations, pH, and colorimetric analyses.

PRELIMINARY STUDIES

Preliminary surveys were conducted during a 3-week period beginning March 27, 1967. During the first week, samples were collected and analyzed for suspended solids, BOD, pH, sludge analyses and phosphates on raw sewage and chlorinated effluent to determine plant loadings and performance. On March 30, hourly samples were analyzed for ortho and total phosphates during a 15-hour period to establish some indication of hourly and diurnal variations. During the following 2 weeks, these studies on plant loading and performance were continued except for phosphates. Jar tests were conducted from April 3-10 for phosphate removal.

JAR TESTS

Jar tests were conducted using various concentrations of iron, both ferric and ferrous; several polymers of the anionic, cationic, and nonionic types and NaOH as calcium carbonate alkalinity. Order of addition, time of contact and types of mixing and flocculation were also studied.

It was found that iron, in both ferrous and ferric forms in concentrations ranging from 15 mg/l to 30 mg/l would substantially remove both *$O\text{-}PO_4$ and $T\text{-}PO_4$. Concentrations below 15 mg/l showed little reduction. The use of ferrous iron resulted consitently in the 90% range of PO_4 removals. Results, when using ferric iron, were consistently lower.

Contact periods, ranging from 0.5 minutes or less to 20 minutes between the iron and sewage were equally effective in phosphate removal. Only 3 of the 6 polymers studied appeared to be effective. One anionic worked well in concentrations from 0.1 mg/l to 1.0 mg/l and another from 0.25 mg/l to 1.0 mg/l. The cationic polymer gave excellent results at a concentration of 30 mg/l; however, at this concentration costs would be prohibitive.

The studies indicated that the polymers should have 30 seconds to 60 seconds rapid mixing followed by 5-10 minutes slow flocculation in order to completely develop the floc.

Further jar studies were conducted using 20 mg/l ferrous iron with 6 minutes detention followed by addition of 40 mg/l of NaOH as $CaCo_3$ alkalinity with 5 minutes detention and final addition of the most effective anionic polymer in concentrations ranging from 0.1 to 1.0 mg/l with 1.0 minute rapid mix and slow flocculation for 10-15 minutes.

Tests were conducted within the indicated ranges to further optimize the dosage rates and reaction times attainable with the available plant structures.

Samples of the above showed consistent removals of 90% or more of $O\text{-}PO_4$ and $T\text{-}PO_4$ in filtered and unfiltered portions respectively. Turbidity as measured with a Helige turbidimeter at 50 m.m. gave readings in the 10-20 range, representing an 80-95% reduction. Iron content was increased from trace concentrations in the raw wastes to 1.0-4.0 mg/l in the treated effluent.

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* $O\text{-}PO_4$ - Orthophosphate
$T\text{-}PO_4$- Total phosphate

PRELIMINARY PLANT STUDIES

On April 11, ferric chloride and the selected polymer treatment was conducted on a plant scale for a period of 3 hours. The ferric iron was fed at the pumping station with approximately 6 minutes detention through the 8-inch force main. The polymer was dripped into the splitting chamber, giving a very short mixing period between polymer additions and settling in the 3 sedimentation tanks.

On the following day, ferrous chloride was fed at the same location, followed 8 seconds later by 40 mg/l of NaOH as $CaCO_3$ alkalinity. This polymer was fed at the splitting chamber. The test period was 5 hours.

On both days, samples were collected at 15-minute intervals. Little overall reduction of T-PO_4 occurred. However, filtered samples of the clarifier influents showed a high incidence of phosphate tie-up by the ferrous iron. The use of ferric iron did not show this. The polymer treated portion would not develop an adequate floc, so settleability and overall removals were very low.

Grab samples of the clarifier influents from both test periods were mixed slowly and an adequate floc formed which settled very well. These samples showed high reductions of both O-PO_4 and T-PO_4.

OBSERVATIONS ON JAR TESTS AND PRELIMINARY PLANT STUDIES

1. Grayling waste water is amenable to treatment with ferrous iron in conjunction with NaOH and polymers for removal of phosphates and suspended matter.
2. Suspended matter, O-PO_4 and T-PO_4 can be reduced to a high degree with this type of treatment, under closely controlled conditions.
3. Successful application of this method of treatment will require modifications at the plant to accommodate flocculation devices for polymer.
4. Ferric iron showed promise of good removals. Further study is needed to demonstrate effectiveness of iron in this form.

MODIFICATION OF PLANT FACILITIES

Following the preliminary plant studies the Grayling City Manager and Council decided to apply this technique in a full-plant study. It was decided to adapt the present facilities at minimum cost making only minor changes in the facilities with no change in the pumping pattern, to determine what might be accomplished with these facilities at this time. It was recognized that formal modifications of the plant, including modification of the pumping pattern to eliminate surging, and the addition of permanent facilities for chemical feeding, mixing and flocculation devices would be required to determine the capability of this plant for effective phosphate removal.

The inlet ends of the 3 settling tanks were modified by removing the wooden dispersal baffle and installing motor driven vertical flocculators located 3 feet from the inlet end. A picket fence baffle was installed 6 feet from the inlet wall across the entire tank width, vertically from a point about 1 foot below the water surface to a depth of about 6 1/2 feet.

Chemical feed equipment was located at the pump station to feed $FeCl_2$ and NaOH.

Polymer feed equipment was installed at the flow splitter chamber and controlled by a float switch which engaged when the flow rose above the weirs and began to enter the settling tanks.

PROCEDURE FOR CHEMICAL ADDITION

Iron chloride in the ferrous form ($FeCl_2$) was fed at the entrance to the pump station grit chamber at a concentration of 15-30 mg/l. Sodium hydroxide was fed at the comminutor at a concentration of 30-50 mg/l approximately 8 seconds after iron addition.

Mixing of these chemicals with the raw waste was accomplished in the wet well pumps and maintained in the force main. Contact time thus provided ranged from 4-8 minutes, most commonly about 6 minutes.

OVERFLOW RATES AND DETENTION PERIODS

Surface overflow rates and detention periods are dependent on rates of pumping at the lift station. The pumping charts for June 20 to August 31 reveal that during periods of daytime sampling (8 a.m. to 5 p.m.) rates of flow varied from about 200 to 550 gpm through the sedimentation tanks. During dry weather, the average flows for these hours ranged from 300 to 400 gpm. Generally, pump combinations changed 10 to 15 times per hour with corresponding variations in rates of flow of 100 gpm or more through the sedimentation tanks.

Detention periods and surface overflow rates for the observed flows based on the net effective tank area and volume computed by deduction of the portion of the tanks between inlet wall and picket fence baffles are as follows:

Rate of Flow GPM	Detention Time Hours	Surface Overflow Rates Gal / sq. ft. / day
200	1.40	600
300	1.60	900
400	1.20	1,200
550	0.87	1,650

The very unstable flow pattern experienced most of the time undoubtedly interferred with effective mixing and flocculation and with settling of suspended matter.

Comparison of rates of flow through the sedimentation tanks from June 20 to August 15 with those for the periods March 29 to June 8 and August 15 to September 14 reveals that a marked increase in flow occurred during June 20 to August 15. This period corresponds with the period of encampment at the National Guard whose sanitary facilities are tributary to the Grayling sewer system.

PERIOD OF THE STUDY

Full-scale plant studies for phosphate removal were commenced on June 20 and continued through September 14. Chemicals were added 7 days per week for the entire period except for September 1-7. Generally, samples were collected and analyzed 3 days per week. On 9 days, chemicals were added in less than established dosage rates by reason of equipment malfunctions and other unusual circumstances. Data for these days are not included in the reported results.

SAMPLING AND TESTING PROCEDURES

1. All flow measurements were obtained by a float-controlled recorder located behind a rectangular weir following the 3 sedimentation tanks. The flow recorder was corrected with a head recording device and was considered to be reasonably accurate.

2. Sampling was carried out by automatic samplers composited in proportion to flow during 24-hour periods; manually collected 9-hour composited samples, 8 a.m. to 5 p.m.; and grab sampling (not included in the reported data).

3. Laboratory analyses for suspended solids, BOD, ortho and total phosphates and iron were conducted according to Standard Methods with one exception: a portion of the iron analysis was conducted with an atomic absorption apparatus.

DISCUSSION OF DATA

All the data obtained is graphically represented in Figures I-VA except for periods when the sewage concentration was affected greatly by sewer flushing (2 days); rain (2 days); when a settling tank was down for repairs (1 day); and those days when there was no chemical treatment or only partial chemical feeds. (See also discussion under "Period of the Study".)

During the period March 29-June 8 before treatment was commenced, suspended solids removals were usually between 30% and 65% with the effluent concentration averaging between 60 mg/l and 90 mg/l. The arithmetic average of all samples, both 24-hour and 9-hour composites, was 157 mg/l in the raw sewage and 78 mg/l in the effluent giving a removal of about 50%.

Removal of suspended solids during chemical treatment, despite high flows and intermittant pumping, averaged between 70% and 85% with the effluent concentration generally between 40 mg/l and 60 mg/l. The arithmetic average during the period was 224 mg/l in the raw sewage and 50 mg/l in the effluent giving a removal of 78%. The average increase in suspended solids removal during the treatment period was 28%.

Statistical plots of the data for suspended solids removal for both periods are shown in Figure IVA. All data for each period are arranged in order of magnitude and plotted on normal probability paper against probability of occurrence. During the period when no chemicals were added, there were wide variations in percent removal ranging from extreme values of 23% to a high value of 81% and a centering or most probable mean value of 51%. Performance was much more stable during the period of chemical treatment as indicated by the much flatter curve plotted through values ranging from 60% to 87% removal with a most probable mean value of 77.5. Applying the overlapping test for statistical difference between the 2 means in the range of 3 standard errors, it is found that the difference is statistically significant and could not occur by mere chance even if the 10 low values for Curve B were elevated so as to be arranged along an extension of the upper part of the curve.

BOD removals before treatment averaged 35% to 50% with the effluent concentration averaging between 85 mg/l and 120 mg/l. The arithmetic average of all samples was 170 mg/l in the raw sewage and 101 mg/l in the effluent, giving a removal of 41%. BOD removals during treatment averaged between 50% and 70% with the effluent concentration averaging between 65 mg/l and 80 mg/l. The arithmetic average during this period was 178 mg/l in the raw sewage and 74 mg/l in the effluent, giving a removal of 58%. The average increase in BOD removal during treatment was 17%.

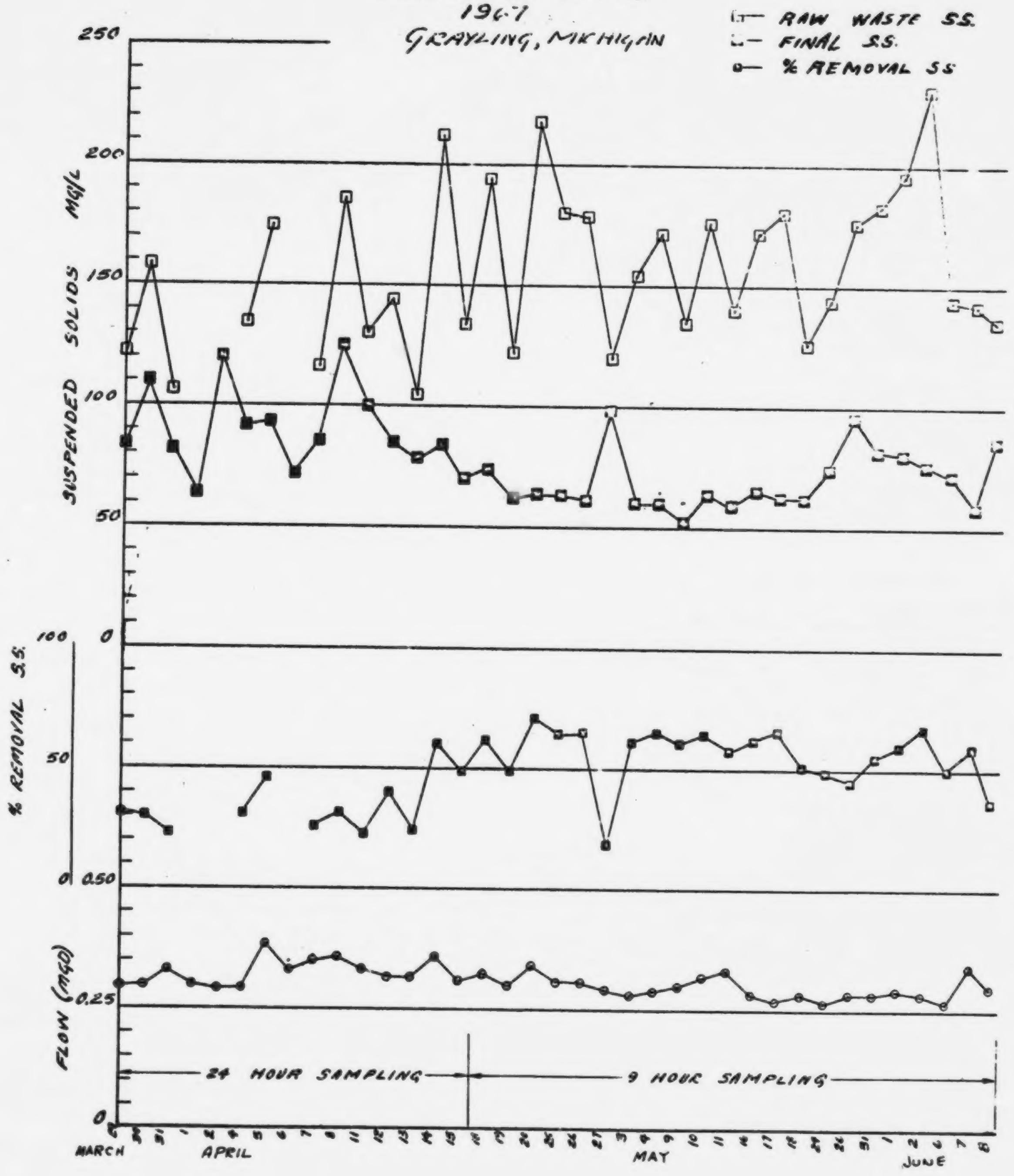
Statistical plots for percent BOD removal are shown in Figure VA in the same manner as for suspended solids. It is apparent that very wide changes in percent removal were experienced during the period when chemicals were not added. The predictable mean value can be determined with values ranging from 0% to 55% removal. However, during the period of chemical additions all except 3 values were 51% removal or higher with all except 4 values between 51% and 69%, giving a relatively stable mean of 57 or 58. Here also, the difference in performance during the 2 periods was statistically significant representing real changes which cannot be accounted for by chance.

Total phosphate analyses during periods without chemical treatment showed no appreciable removal.

Total phosphate concentrations during chemical treatment usually ranged between 30 mg/l and 60 mg/l in the raw waste and between 9 mg/l and 18 mg/l in the effluent. The phosphate removal averaged between 60% and 80%. The arithmetic averages during treatment were 4[illegible].5 mg/l in the raw sewage and 13.5 mg/l in the effluent, giving a removal of 72%.

Total iron analysis of the waste water indicated an average of 1.0 mg/l to 1.3 mg/l in the plant effluent without chemical treatment. During treatment, the iron in the raw waste increased to 1.9 mg/l. The average iron concentration in the effluent during treatment was 6.1 mg/l, ranging from 4 mg/l to 8 mg/l. At the 7-day once in 10-year drought flow of about 40 cfs, a sewage flow of 0.4 MGD with a concentration of 6 mg/l of iron in the waste discharge would produce a concentration in the total river of about 0.1 mg/l.

FIGURE I
NO CHEMICAL TREATMENT
SUSPENDED SOLIDS
1967
GRAYLING, MICHIGAN



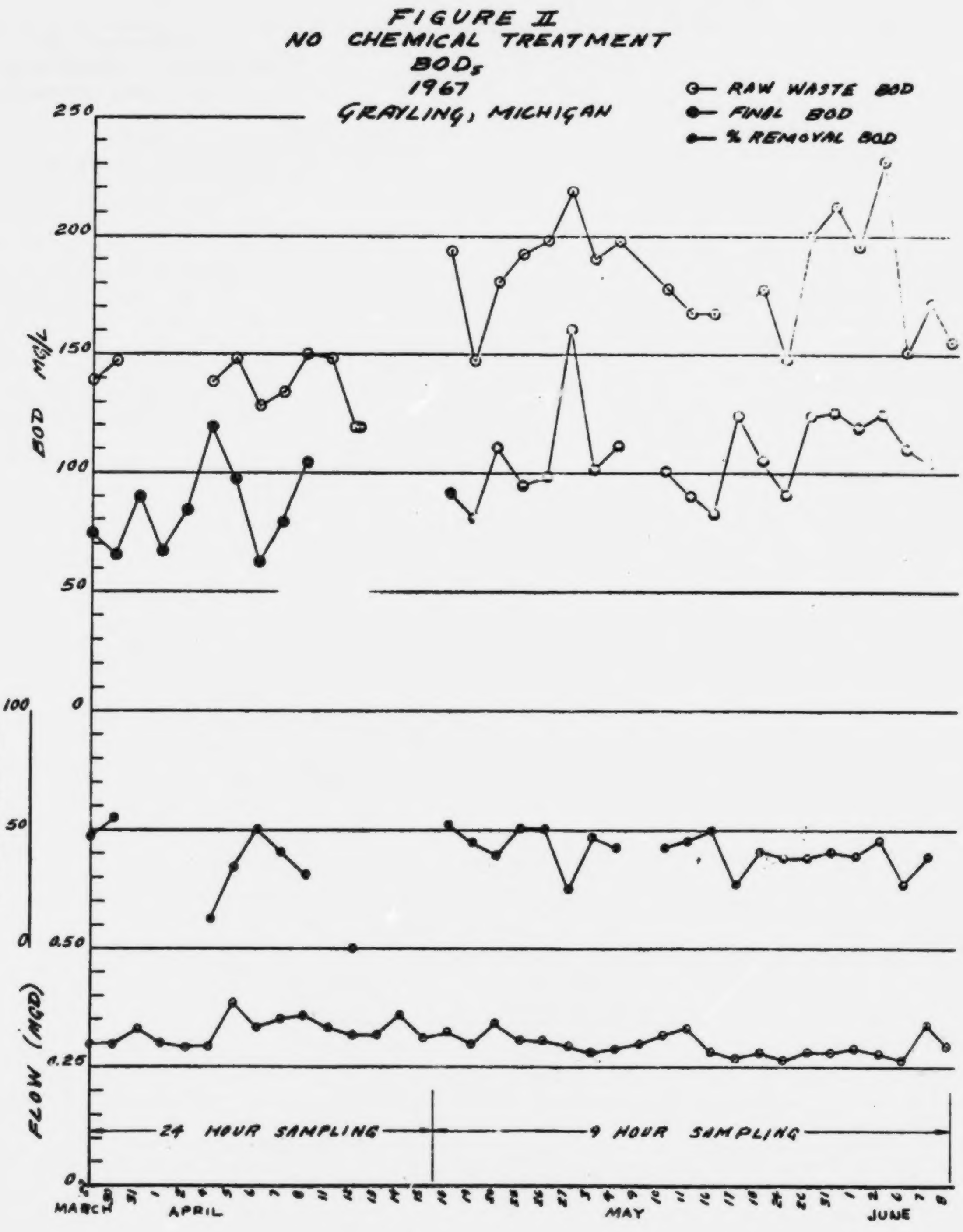


FIGURE II
NO CHEMICAL TREATMENT
BOD5
1967
GRAYLING, MICHIGAN

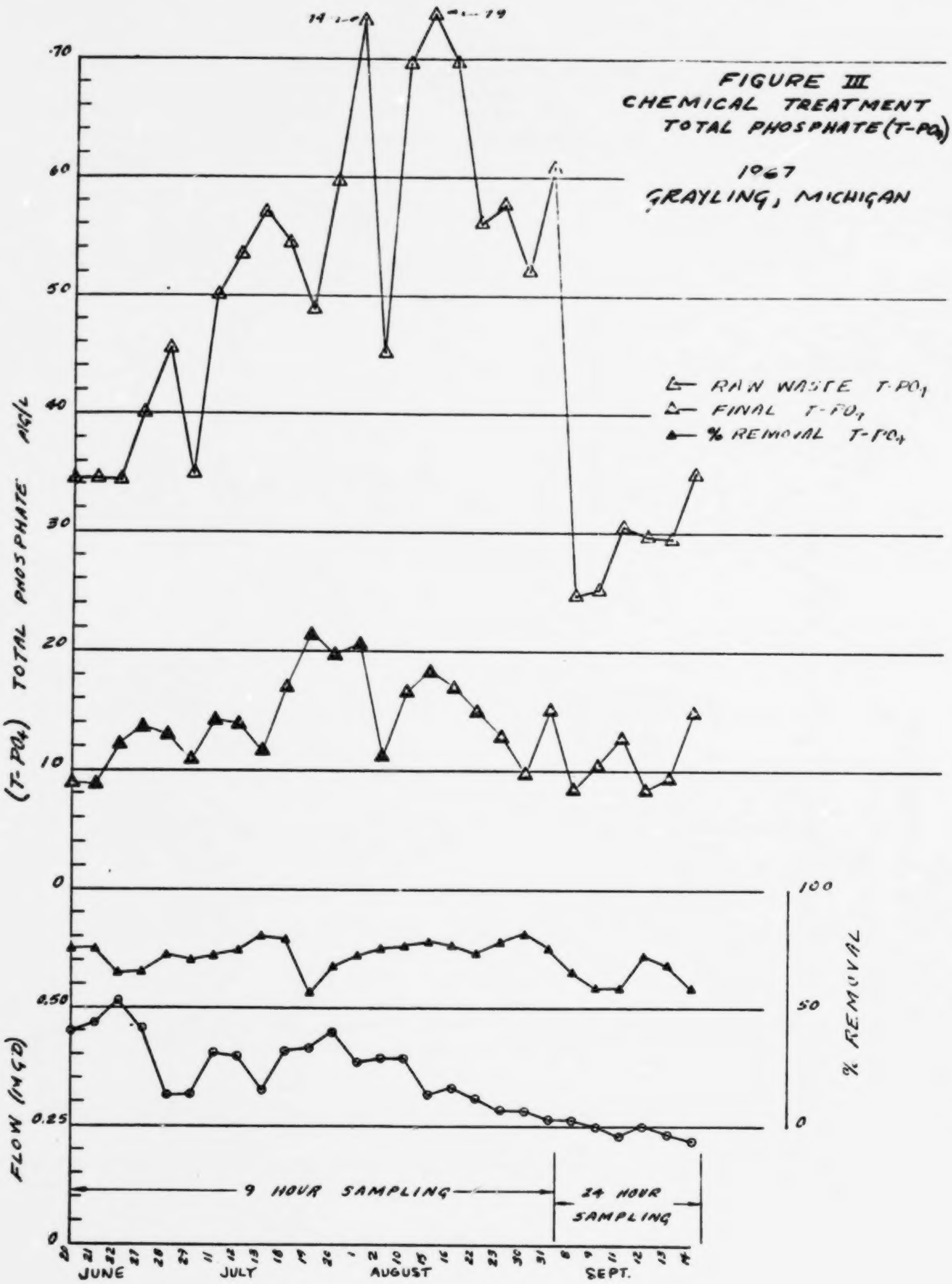


FIGURE III
CHEMICAL TREATMENT
TOTAL PHOSPHATE (T-PO4)

1967
GRAYLING, MICHIGAN

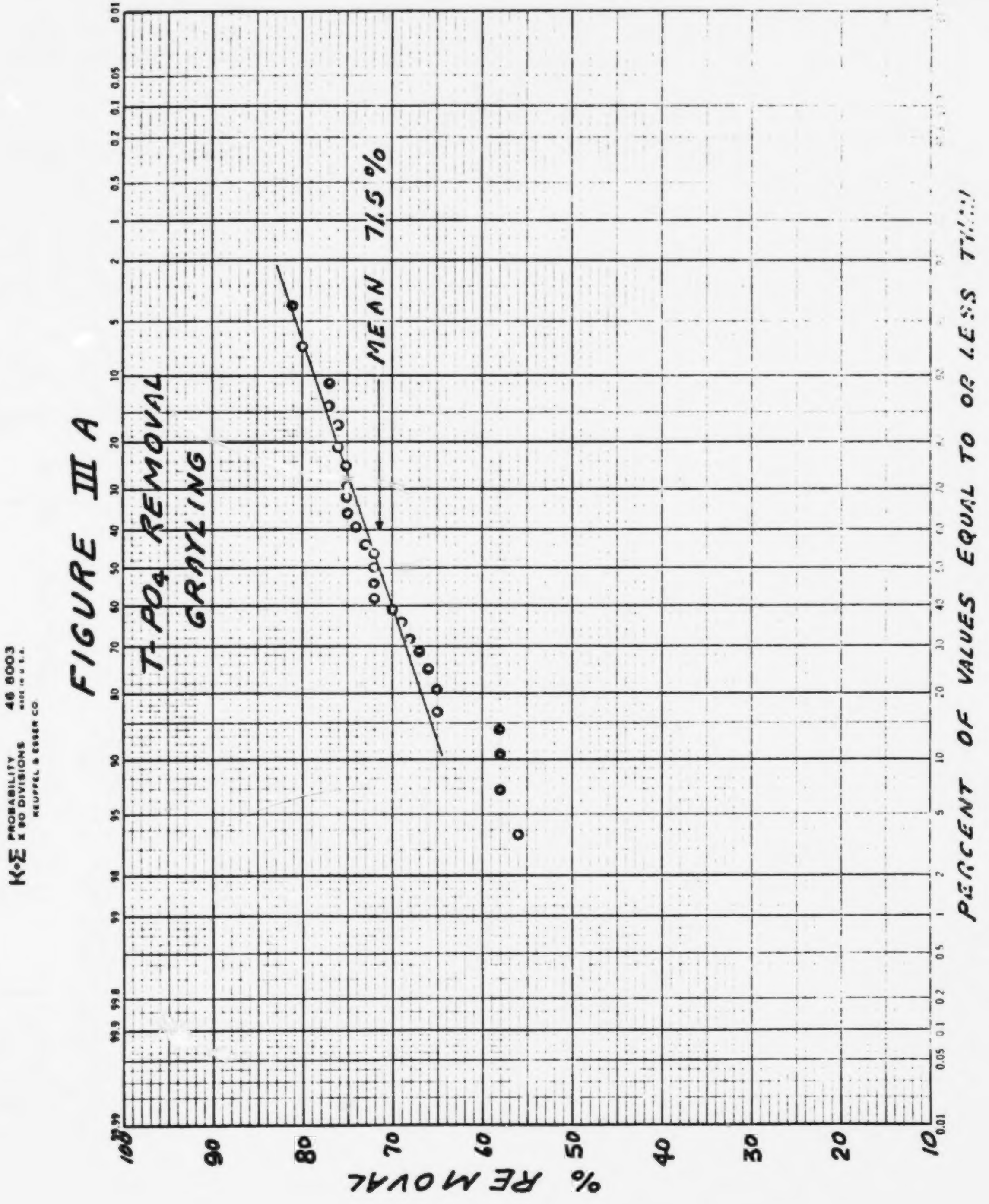


FIGURE III A

T-PO4 REMOVAL
GRAYLING

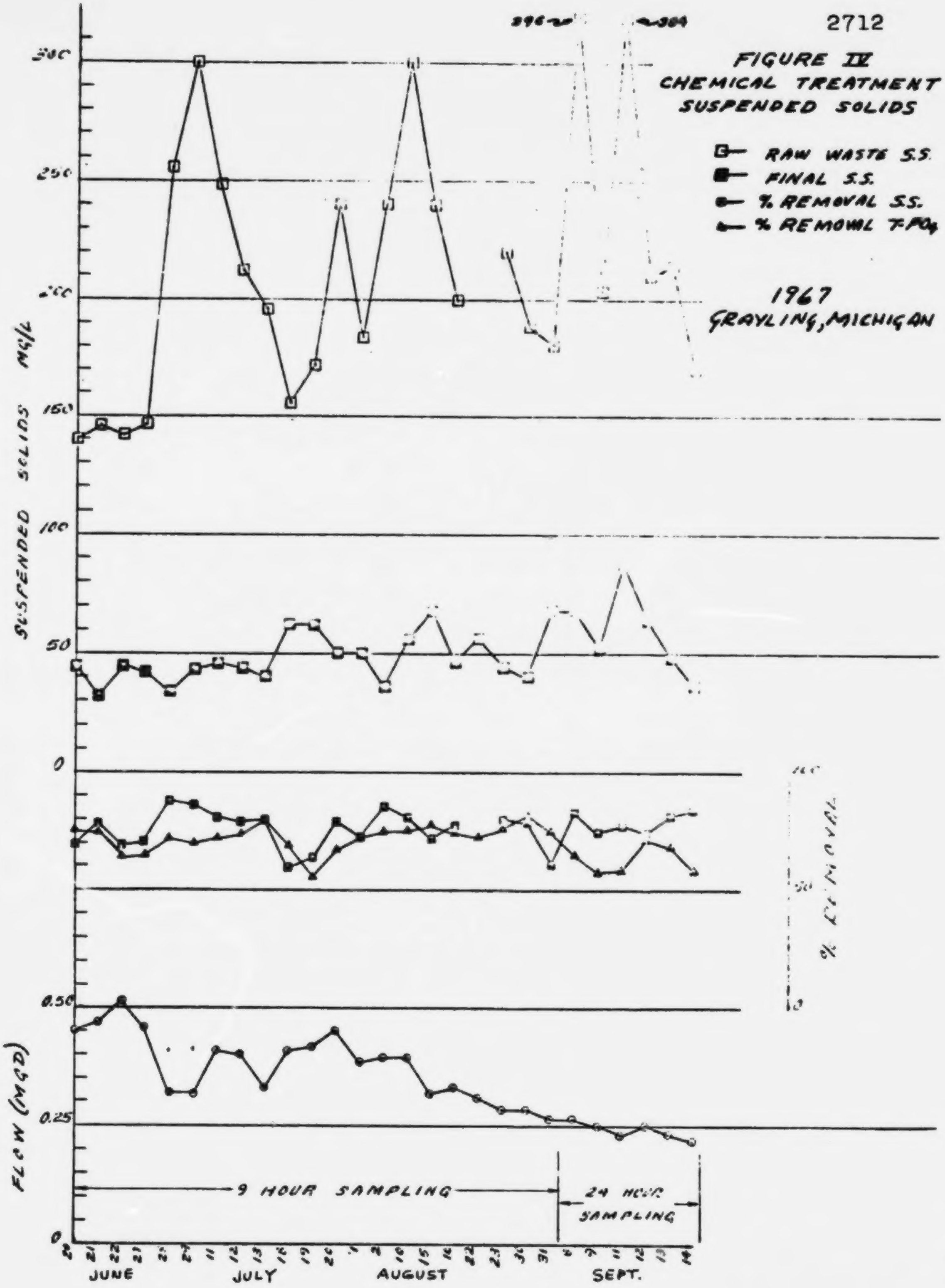
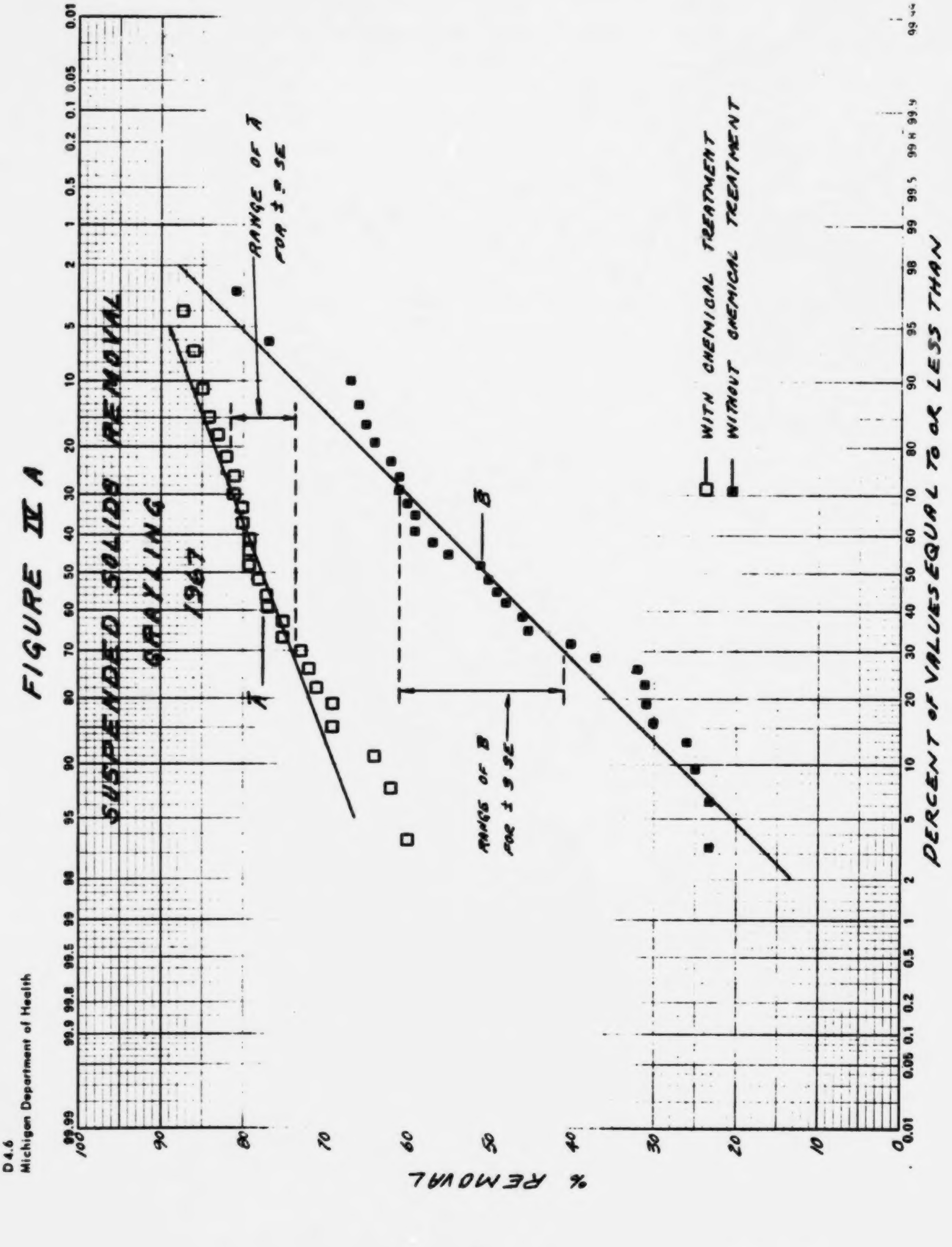


FIGURE IV
CHEMICAL TREATMENT
SUSPENDED SOLIDS

1967
GRAYLING, MICHIGAN


D4.6
Michigan Department of Health
FIGURE IV A
SUSPENDED SOLIDS REMOVAL
GRAYLING
1967
% REMOVAL
PERCENT OF VALUES EQUAL TO OR LESS THAN
RANGE OF A̅ FOR ± 2 SE
RANGE OF B̅ FOR ± 2 SE
A̅
B̅
□ WITH CHEMICAL TREATMENT
■ WITHOUT CHEMICAL TREATMENT
0
10
20
30
40
50
60
70
80
90
100
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.99

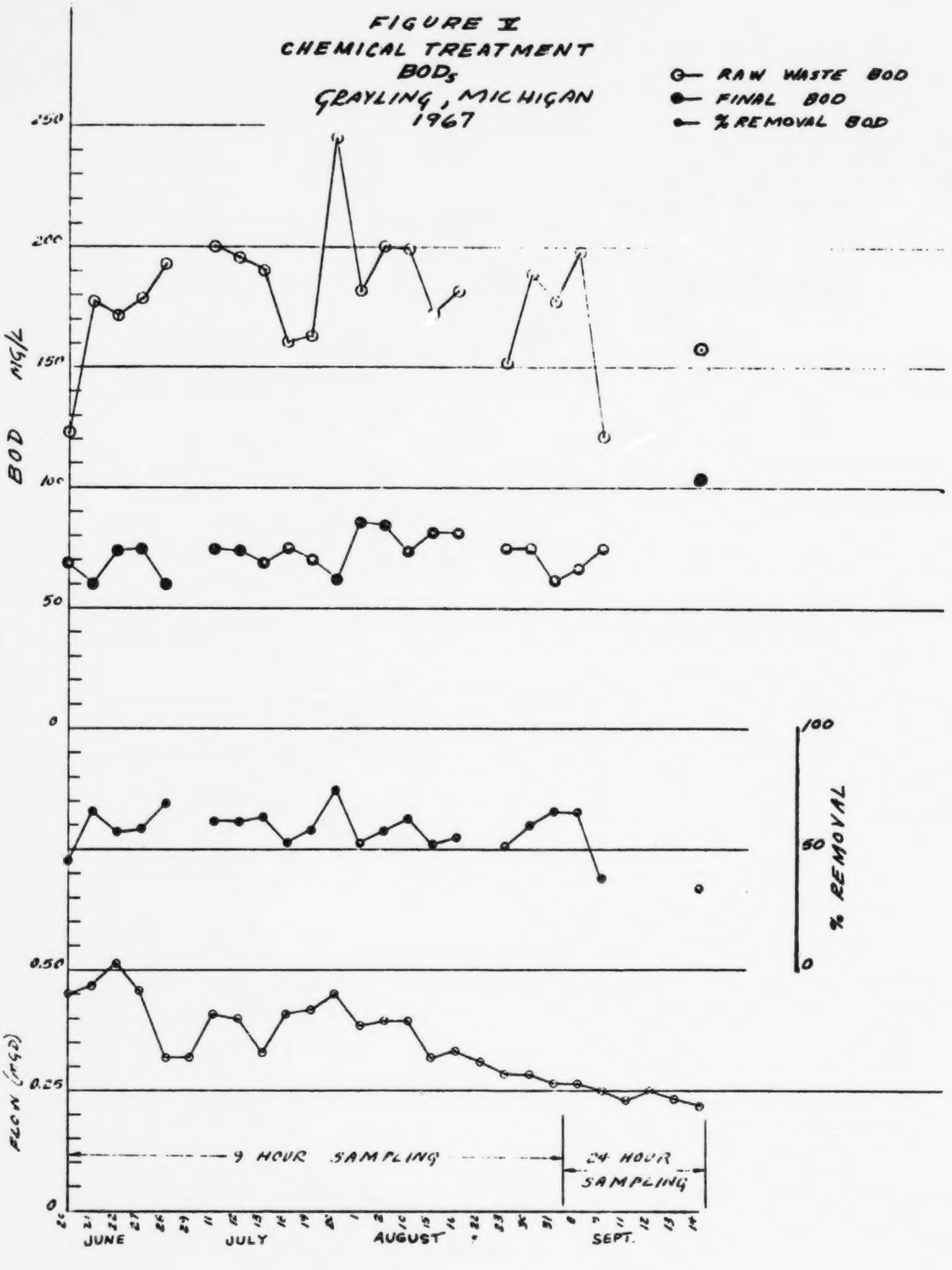
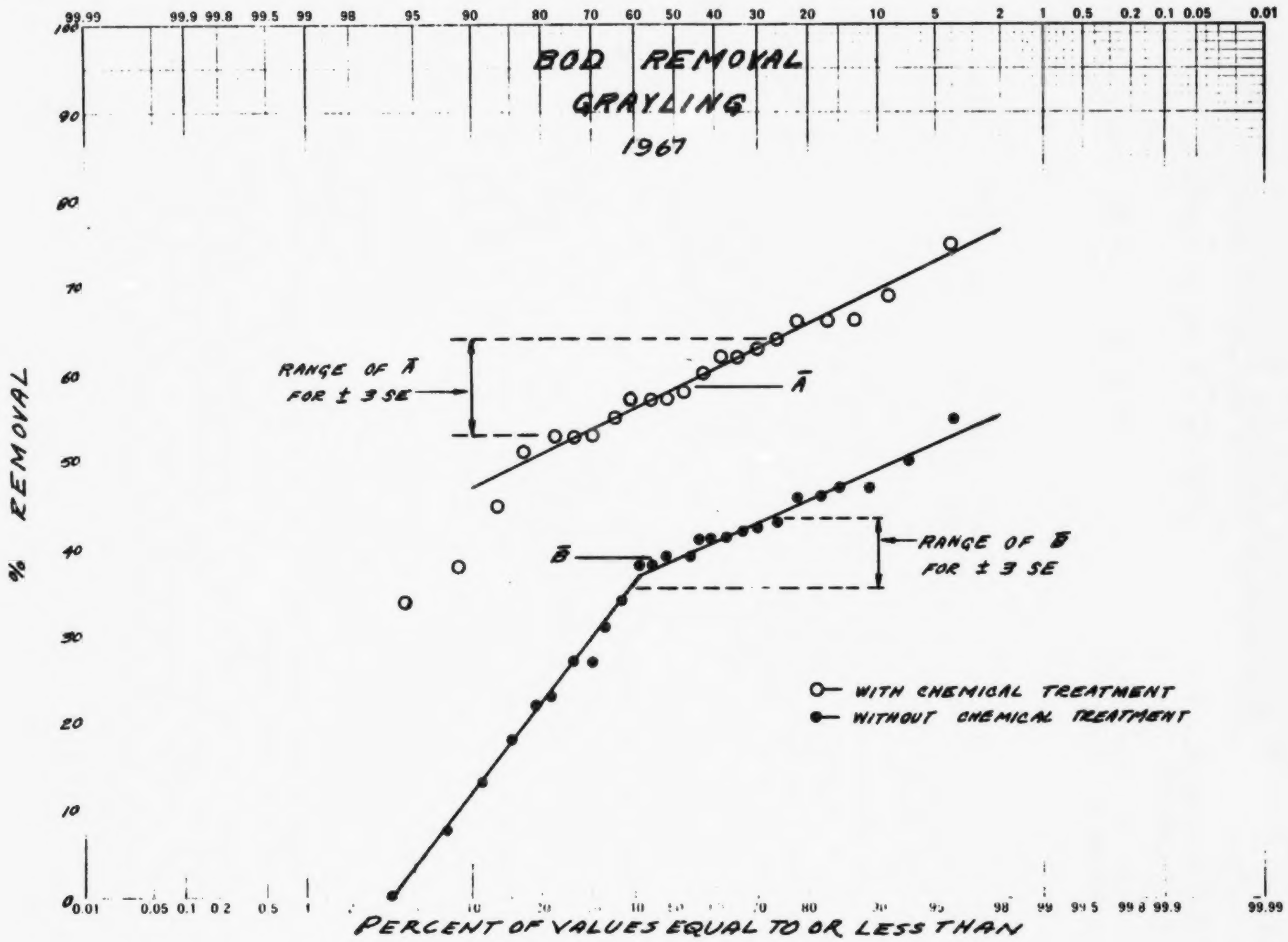


FIGURE V
CHEMICAL TREATMENT
BOD_5
GRAYLING, MICHIGAN
1967

D4.6
Michigan Department of Health

FIGURE V A



OBSERVATIONS DURING CHEMICAL TREATMENT

1. Percent total phosphate removal followed the same general pattern as suspended solids removal.
2. Percent phosphate removal appeared to be independent of the flow rate and raw suspended solids concentration.
3. Percent phosphate removal appears to be independent of the raw phosphate concentration.
4. Removal of suspended solids was consistantly in the range of 70% to 85% and the concentration in the treated effluent was generally in the range of 40 mg/l and 60 mg/l although raw waste concentrations varied greatly from day to day with extreme values ranging from less than 150 mg/l to greater than 300 mg/l.
5. Percent BOD removal followed much the same pattern as suspended solids removal.
6. During the period of chemical treatment, concentrations of suspended solids and BOD were much more uniform in the treated waste than noted during periods when chemicals were not applied.

CONCLUSIONS

The following conclusions may be deduced from these studies:

1. Bench scale studies demonstrated that thorough mixing of ferrous iron with raw sewage for a period of 1 minute or less forms an insoluble product of unknown structure with little or no measurable orthophosphates and that total phosphates in the range of 80% to 90% or higher may be removed thereafter from the waste by the addition of alkalinity and anionic polymers with gentle flocculation followed by a short period of sedimentation.
2. Bench studies indicated removal of turbidity in the order of 80% to 95%.
3. Bench studies demonstrated that certain polymers are more effective than others.
4. Plant scale studies confirmed bench scale observations that thorough mixing of the polymer followed by gentle flocculation are essential for maximum effective removal of total phosphates
5. Plant scale studies demonstrated that removal of 65% to 75% of total phosphates, removal of 70% to 85% of suspended solids, and removal of 50% to 70% 5-day BOD can readily be achieved on the Grayling waste water with minor alterations in the conventional primary treatment facilities.

6. Mixing and flocculation achieved with the minor modifications made and installed at this plant were much less than required for maximum removal of total phosphates. Installation of equipment and facilities in a conventional manner for such purposes may be expected to increase substantially the effectiveness of removal of total phosphates with related higher percentages of removal of waste constituents as measured by the suspended solids and BOD tests.

APPENDIX G

STUDIES ON REMOVAL OF PHOSPHATES
AT
LAKE ODESSA, MICHIGAN

STUDIES ON REMOVAL OF PHOSPHATES

AND

RELATED REMOVAL OF SUSPENDED MATTER AND BIOCHEMICAL OXYGEN DEMAND

AT

LAKE ODESSA, MICHIGAN

MAY - OCTOBER 1967

CONDUCTED BY:

WASTEWATER SECTION
DIVISION OF ENGINEERING
MICHIGAN DEPARTMENT OF PUBLIC HEALTH

AND

THE DOW CHEMICAL COMPANY

INTRODUCTION

Lake Odessa is a community of 1,800 located on the shores of Jordan Lake, an inland lake in west-central Michigan, where intensive water-related recreational activities are carried out on a year-round basis. The rate of eutrophication of Jordan Lake, a naturally eutrophic lake, has been greatly accelerated by the organics and nutrients discharged from the municipal wastewater treatment plant in recent years. It has been determined that a higher degree of treatment, including nutrient removal, is necessary to preserve and enhance water quality for accustomed and desired recreational uses.

Studies on phosphate removal using ferrous chloride and polymers, being conducted cooperatively by the Department and the Dow Chemical Company at Grayling, Michigan, showed excellent promise of substantial reduction of total phosphates and suspended solids. With this background, arrangements were made with the Dow Chemical Company and the Village of Lake Odessa to conduct a study at Lake Odessa, utilizing the principles developed by Grayling, and adapting them to these particular waste characteristics and physical facilities.

Initial bench studies, conducted early in June 1967, indicated that Lake Odessa waste water would respond to chemical treatment in a manner similar to that experienced at Grayling. It was then decided to proceed with plant scale studies. No significant modifications in plant facilities were made and temporary facilities for chemical feeding were installed.

The plant scale studies were performed cooperatively by personnel of the Department, the Dow Chemical Company, and the Village of Lake Odessa. These studies, begun in early June 1967, were conducted through September. During this period, plant loadings fluctuated widely as a result of the operations of a sizeable food processing industry in the Village.

PURPOSE OF STUDY

To conduct a study, cooperatively with the Dow Chemical Company, to ascertain the amenability of Lake Odessa waste water to treatment utilizing ferrous chloride in conjunction with anionic polymers for removal of phosphates, and related removal of suspended matter and biochemical oxygen demand, by both bench scale work and plant scale operation.

DESCRIPTION OF PLANT FACILITIES

The Lake Odessa wastewater treatment facilities, constructed in 1954 to replace an earlier plant, consist of:

1. Combination comminutor-screen chamber.
2. Parshall flume-measuring raw wastewater flow.

3. One primary sedimentation tank, 12 feet x 50 feet with an average water depth of 8 feet, equipped with mechanical sludge and scum removal equipment. (Volume = 4,800 cubic feet)

4. Pumping station - primary effluent plus portion of trickling filter effluent pumped to trickling filter with two 450 gallons-per-minute pumps.

5. One trickling filter - 62 feet diameter x 6 feet media depth. (18,100 cubic feet of media) Recirculation from trickling filter effluent to trickling filter influent

6. One secondary sedimentation tank - identical to primary sedimentation tank.

7. Disinfection facilities - gas type chlorinator with a capacity of 150 pounds a day, equipped to feed chlorine both to primary and secondary sedimentation tank inlets. The sedimentation tank serves as a chlorine contact chamber.

8. One, fixed cover, sludge digestion tank with capacity of 13,758 cubic feet. Original plant septic tanks, with a capacity of 13,330 cubic feet, are used for sludge storage and concentration.

9. Sludge drying beds with a total area of 6,560 square feet.

10. Service building with a laboratory fully equipped to conduct a program of wastewater analysis; i.e., solids analyses, BOD determinations, pH, colorimetric analyses.

BENCH SCALE STUDIES

Jar tests were conducted during the period June 7-15, 1967, using variable speed laboratory mixing apparatus with 6 jars in parallel, to determine amenability of Lake Odessa waste water to phosphate removal by chemical treatment. Various concentrations of ferrous chloride, polymers and sodium hydroxide were used. Order of addition, time of contact and types of mixing and flocculation were studied.

It was found that iron in the form of ferrous chloride, in concentrations ranging from 15 to 40 mg/l (Fe^{++}) would consistently remove orthophosphate in the 90% range.

Contact periods, ranging from 1 to 5 minutes between the iron and waste water, were equally effective in phosphate removal. Following the experience gained in the Grayling studies, only 2 anionic polymers were used in the bench scale studies, 1 proving to be very effective and superior to the other.

The bench scale studies indicated that the polymers should have approximately 1 minute of rapid mixing, followed by 2-3 minutes of slow flocculation in order to develop an optimum floc.

It was determined that the chemical dosage regime to be established for plant scale studies would include the following average feed rates:

1. Ferrous iron = 30 mg/l. - (as Fe^{++}); Sodium hydroxide = 30 mg/l, (as $CaCO_3$); polymer = 0.5 mg/l.

OBSERVATIONS - BENCH SCALE STUDIES

1. Lake Odessa waste water is amenable to treatment with ferrous iron in conjunction with sodium hydroxide and polymers for removal of phosphates, under closely controlled conditions.

2. Successful application of this method of treatment may require modifications in plant facilities to accommodate chemical feeding, mixing and flocculation devices for optinum floc development with polymers.

PLANT SCALE STUDY

Following the bench scale studies, it was determined by the Lake Odessa Village Council to proceed to apply this technique in a full-plant study. It was decided to determine what degree of phosphate removal could be achieved by the addition of chemicals in a manner as closely approaching the principles followed in the bench scale studies as possible without modification in plant facilities.

Chemical feed equipment was located at a sewer manhole some 500 feet upstream from the comminutor chamber at the plant site to feed ferrous chloride and sodium hydroxide into the raw wastewater flow. Polymer feed equipment was installed at the comminutor chamber. All chemicals were applied with electrically driven diaphragm-type chemical-feed pumps.

PROCEDURE FOR CHEMICAL ADDITION

Iron chloride in the ferrous form ($FeCl_2$) was fed into the plant influent sewer through plastic tubing inserted through a manhole located some 500 feet upstream from the comminutor chamber, extending upstream from the manhole. Sodium hydroxide was fed through plastic tubing inserted through the same manhole, extending downstream from the manhole a distance such that the sodium hydroxide was applied to the wastewater flow some 10-15 seconds after the iron was applied. Turbulence in the sewer was depended on for mixing of these chemicals with the raw waste. The contact time while flowing through the 500 feet of sewer to the comminutor chamber averaged about 4 minutes. Polymer was fed to the raw waste flow at the comminutor chamber.

PRIMARY SEDIMENTATION

Surface Settling Rates and Detention Periods

Surface settling rates and detention periods were dependent on rates of raw waste flow arriving at the plant from the gravity sewer. Daily average surface settling rates varied during the study period from 170 to 970 gallons per day per square foot, with wide fluctuations occurring throughout the entire period, caused essentially by variations in operations at a local food processing industry. Average daily primary sedimentation detention periods varied from 1.9 to over 10 hours during the survey.

SECONDARY TREATMENT

Trickling Filter Loading Rates

Trickling filter loading rates during the formal study period during which chemicals were fed, (August 6 to September 13) ranged from 1 to 47 pounds of 5-day BOD per day per 1,000 feet^3. During the period of study following cessation of chemical feeding, (September 14 to 29) these loadings ranged from 5 to 43 pounds of 5-day BOD per day per 1,000 feet^3.

Sedimentation - Surface Settling Rates and Detention Periods

Since the secondary settling tank is identical to the primary settling tank, and flows through the secondary tank are equal to those through the primary tank, surface settling rates and detention periods were identical to those reported under "Primary Sedimentation".

SLUDGE DIGESTION

A record of sludge digester loadings and gas production is presented for the months April-October, inclusive, for the years 1966 and 1967 for comparative purposes. In 1967, the monthly average digester loading ranged from 12.4 pounds volatile solids per day per 1,000 feet^3 (May) to 52.5 pounds volatile solids per day per 1,000 feet^3 (July).

PERIOD OF THE STUDY

Full-scale plant studies for phosphate removal were conducted from July 5 through September 29, 1967. Samples were collected and analyzed 5 days per week. Testing was limited to BOD and suspended solids during the initial period July 5-20 when no chemicals were fed. Chemical feeding was commenced on July 21. The period July 21-August 3 was considered as a "start-up period" during which the process and techniques were stabilized. Sampling and testing for BOD, suspended solids, and ortho and total phosphates were conducted during this "start-up period". (Data for this period is not included in the reported results.) Continuous chemical feeding with sampling and analysis for BOD, suspended solids and phosphates was carried out from August 6 through September 13. On 6 days during this period, chemicals were added in less than established dosage rates by reason of equipment malfunctions and other unusual circumstances. Data for these 6 days are not included in the reported results. Complete data on BOD, suspended solids and phosphates was obtained and is reported herein for the period September 14-29, following cessation of chemical feeding.

SAMPLING AND TESTING PROCEDURES

1. All flow measurements were obtained by a flow recorder operating in conjunction with a 6-inch parshall flume located in the comminutor chamber.
2. Sewage sampling was accomplished by use of suction-type constant rate composite samplers. Hand collected samples were obtained for digester supernatant liquor analyses.
3. Laboratory analyses for suspended solids, BOD, and ortho and total phosphates were conducted according to Standard Methods. Iron analyses were performed using an atomic absorption apparatus. Digester sludge was examined by X-ray defraction for presence of "Vivianite" - ferrous phosphate [$Fe_3(PO_4)_2 \cdot 8H_2O$].

DISCUSSION OF DATA

The data obtained during the study is graphically represented in Figures I through V, and in Tables 1 and 2, except for periods where only partial or no chemical feeding was accomplished. (See also discussion under "Period of the Study".)

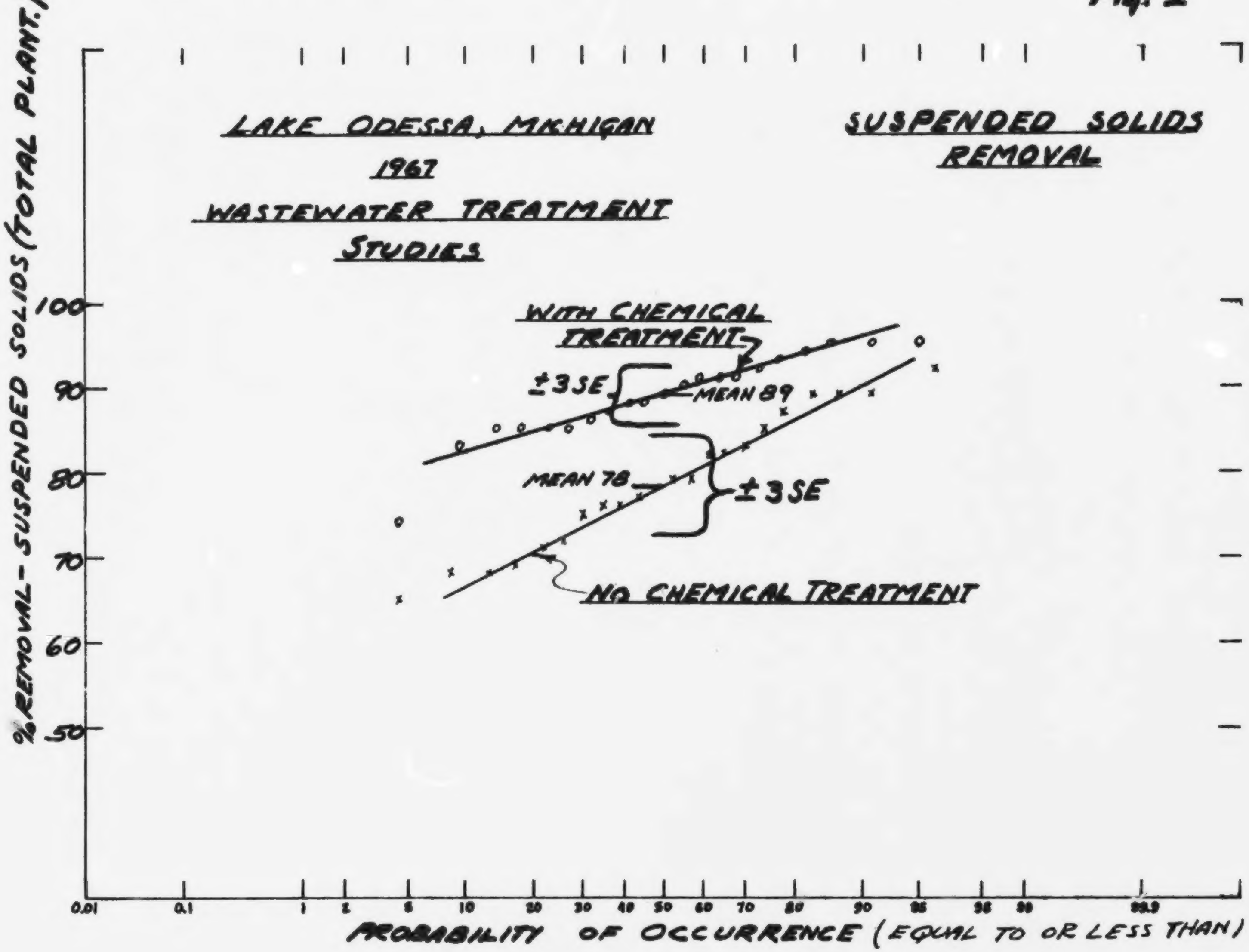
Suspended Solids

Statistical plots of the data for suspended solids removal for periods both with and without chemical treatment are shown in Figure I. All data for each period are arranged in order of magnitude and plotted on normal probability paper against probability of occurrence. During the period of no chemical treatment, percent removals of suspended solids varied widely from extreme values of 65% to a high of about 90% with a centering or most probable mean value of 78%. Performance was much more stable during the period of chemical treatment as indicated by the flatter curve plotted through values ranging from about 82% to 95% removal with a most probable mean value of 89%. Applying the overlapping test for statistical difference between the 2 means in the range of 3 standard errors, it is found that the difference is statistically significant and could not occur by mere chance. Figure II also illustrates the more stable performance at a higher level of efficiency of BOD removal attained during the period with chemical treatment as compared with the period when no chemicals were added.

Biochemical Oxygen Demand

Statistical plots for BOD removal are shown in Figure III in the same manner as for suspended solids. It is apparent that very wide changes in BOD removal were experienced during the period when chemicals were not added. Percent removal of BOD during this period ranged from a low value of 24% to 73%. However, during the period of chemical treatment, all except 3 values were 72% removal or higher with all except 6 values between 72% and 89%, indicating a much more stable condition. The mean value for percent BOD removal during chemical treatment was 82%. Here, also, the difference in performance during the 2 periods was statistically significant, representing real changes which cannot be attributed to chance.

Fig. I



LAKE ODESSA, MICHIGAN
1967
WASTEWATER TREATMENT
STUDIES
SUSPENDED SOLIDS
REMOVAL
WITH CHEMICAL
TREATMENT
± 3SE
MEAN 89
MEAN 78
± 3SE
NO CHEMICAL TREATMENT
% REMOVAL - SUSPENDED SOLIDS (TOTAL PLANT.)
100
90
80
70
60
50
0.01
0.1
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.9
PROBABILITY OF OCCURRENCE (EQUAL TO OR LESS THAN)

Fig II

LAKE ODESSA, MICHIGAN
1967
WASTEWATER TREATMENT STUDIES
SUSPENDED SOLIDS

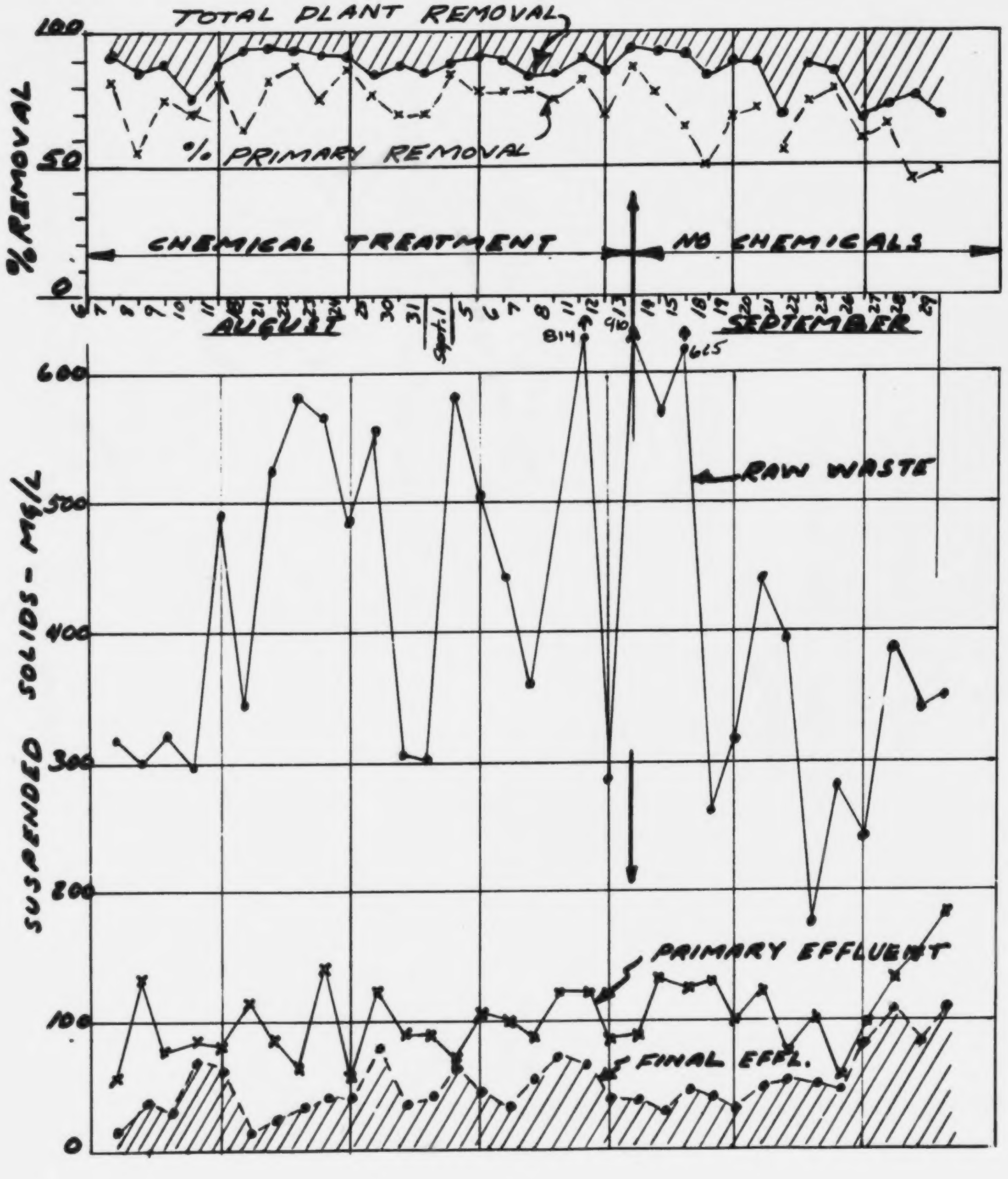


FIG. III

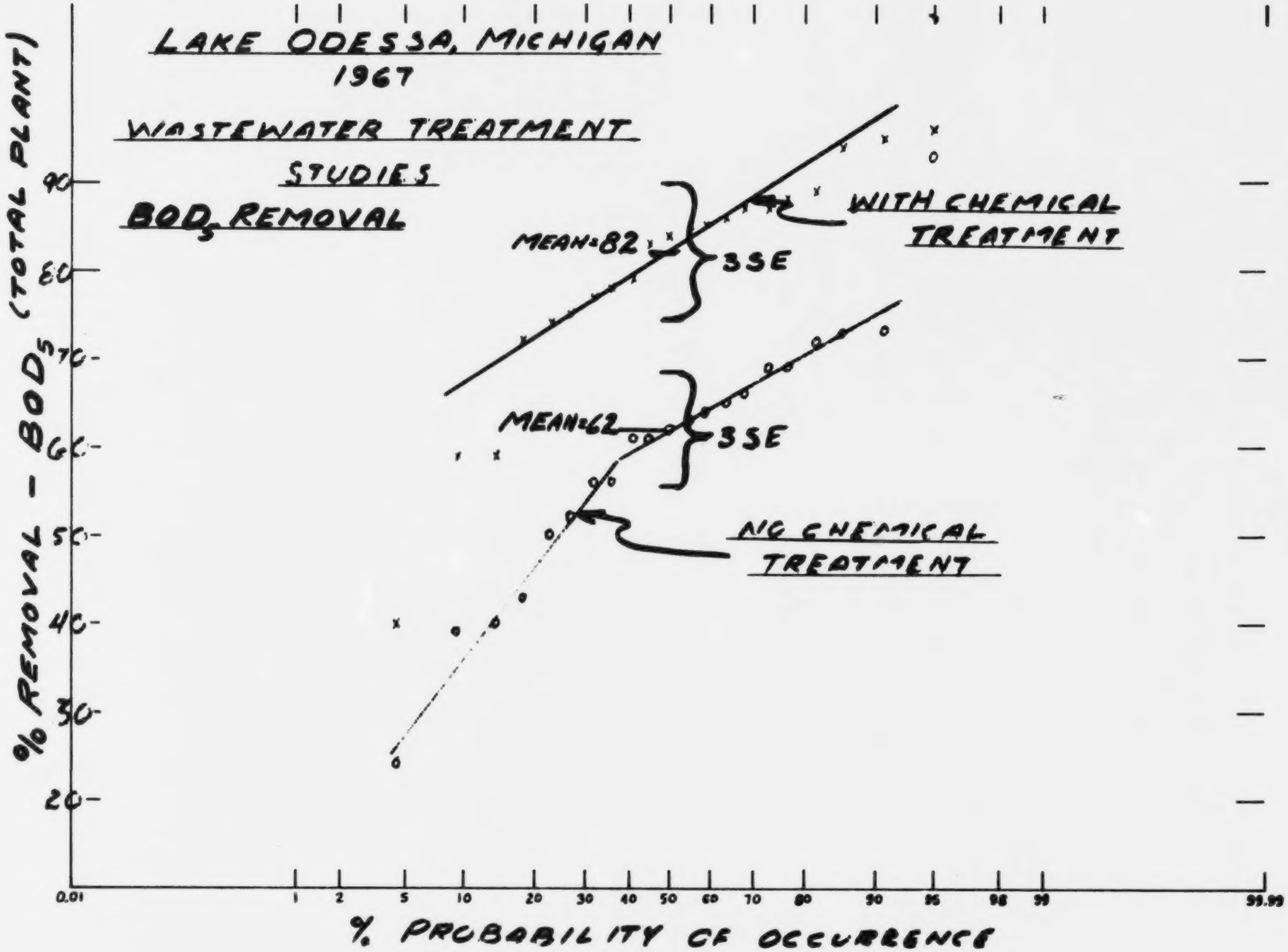

LAKE ODESSA, MICHIGAN
1967
WASTEWATER TREATMENT
STUDIES
BOD5 REMOVAL
MEAN=82
3SE
WITH CHEMICAL TREATMENT
MEAN=62
3SE
NO CHEMICAL TREATMENT
% REMOVAL - BOD5 (TOTAL PLANT)
90
80
70
60
50
40
30
20
% PROBABILITY OF OCCURRENCE
0.01
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.99

Table 1 shows also that the percent removal of BOD with chemical treatment exceeded that obtained without chemicals in each trickling filter loading range with respect to both minimum and average percent BOD removals attained within each loading range. It is noted that trickling filter loadings during the chemical treatment period remained below 50 pounds per day per 1,000 feet^3, while higher loadings were experienced on 7 days during the period when no chemicals were used. Figure IV shows that BOD removal was at a higher level and more stable during the chemical treatment period.

Phosphates

Total phosphate concentrations during the period of chemical treatment usually ranged between 20 mg/l and 60 mg/l in the raw waste and between 4 mg/l and 7 mg/l in the final effluent. A statistical plot of phosphate percent removal values obtained during the chemical treatment period is shown in Figure V. Except for 3 days in this period, the total phosphate removal was 75% or above, ranging between 75% and 93%, with a mean value of 82%.

Total phosphate analysis during periods without chemical treatment showed low and widely varying removals, ranging from 0% to 49%. (See Figure VI)

Iron

Total iron analysis indicated an average of 4.2 mg/l in the plant effluent during the chemical treatment period, ranging from 0.7 mg/l to 10.0 mg/l.

Sludge Digestion Liquor

Monthly average sludge digestion data for the months of April through October, both for 1966 and 1967, are shown in Table 2. These data show average monthly values of gas production, volatile solids loadings, and temperature. It is noted that a large withdrawal of digested sludge from the digester was made in mid-July 1967, undoubtedly accounting for the decreased gas production rate during that month.

Analysis of total phosphates and orthophosphates in the digester supernatant liquor made during the period preceeding chemical treatment showed an average of about 373 mg/l total phosphates and 81 mg/l orthophosphates. These values represent the average results of samples collected and analyzed on 7 days preceeding chemical treatment. Supernatant samples collected and analyzed on 10 days during the latter portion of the chemical treatment period showed an average of 69 mg/l total phosphates and 22 mg/l orthophosphates. While this data on the digester supernatant liquor is limited in quantity, it appears to support the conclusions drawn by E. A. Thomas in his report on studies at the Uster treatment plant at Zurich, Switzerland, that even though iron-phosphate sludge is fed continuously to a digester, the phosphates bound in it apparently are not liberated in the sludge digestion process, rather, a further reduction of the phosphate concentration in the digester liquor takes place, indicating that the iron-phosphate sludge is capable of binding additional phosphates in the digester.

Table 1

LAKE ODESSA, MICHIGAN
1967
WASTEWATER TREATMENT STUDIES

TOTAL PLANT BOD REMOVAL COMPARISON AT VARIOUS TRICKLING FILTER LOADINGS

July 5-September 29, 1967
(42 days data)

Trickling Filter 5-day BOD Loading lbs/day/1000 Ft.^{3}	No Chemical Treatment			With Chemicals Added		
	Number of Values	% 5-day BOD Removal		Number of Values	% 5-day BOD Removal	
		Range	Arithmetic Average		Range	Arithmetic Average
1-10	1	---	66	7	65-95	81
11-20	4	24-72	50	5	40-87	72
21-30	4	50-65	60	4	59-96	84
31-40	5	43-93	65	3	78-88	82
41-50	- - -	No Values	- - -	2	74-83	78
51-60	- - -	No Values	- - -	- - -	No Values	- - -
61-70	3	52-69	59	- - -	No Values	- - -
71-80	- - -	No Values	- - -	- - -	No Values	- - -
81-90	1	---	39	- - -	No Values	- - -
91-100	1	---	69	- - -	No Values	- - -
101-110	2	61-73	67	- - -	No Values	- - -

LAKE ODESSA, MICHIGAN

1967

WASTEWATER TREATMENT STUDIES

BOD5

FIG. IV

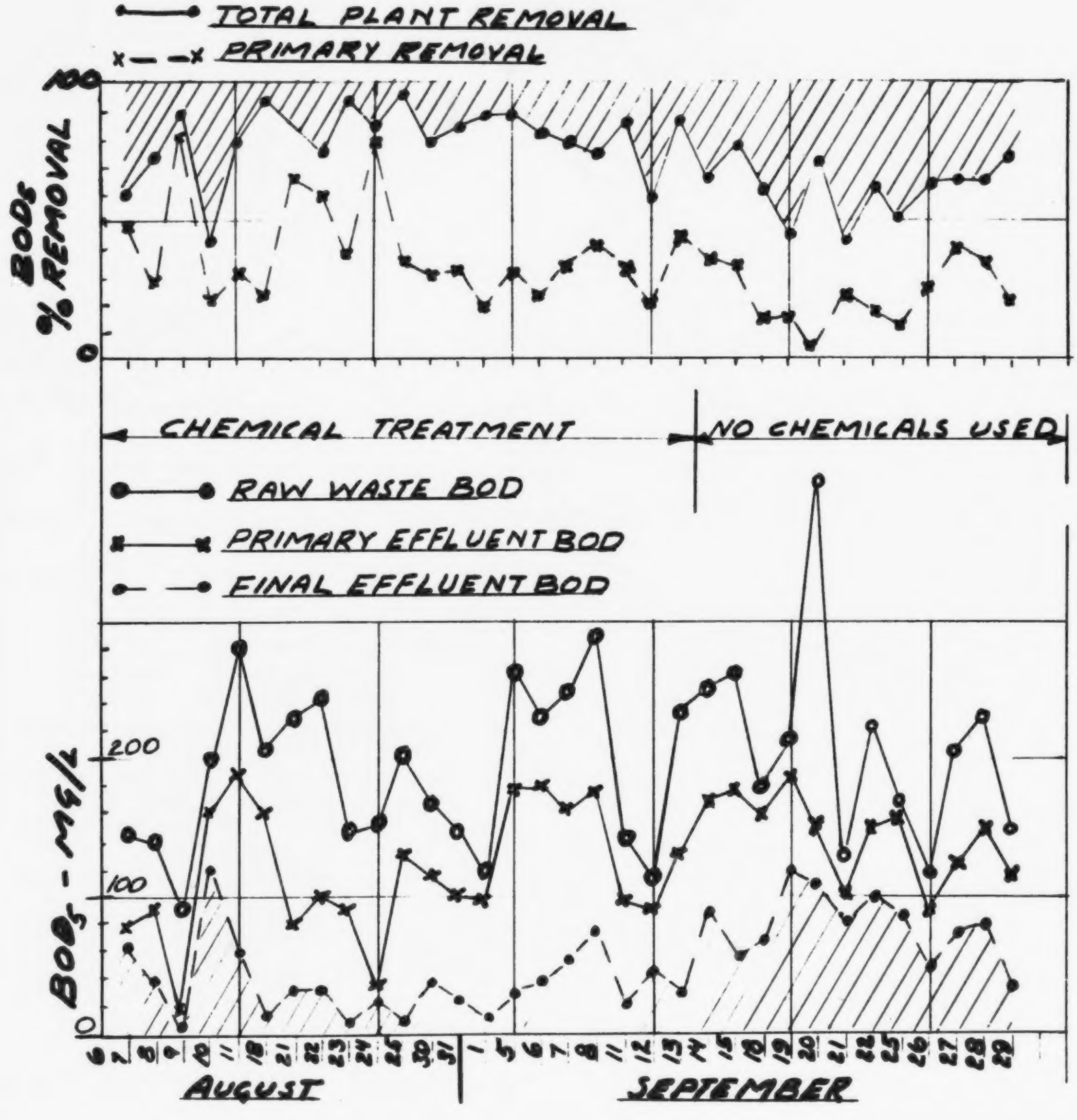
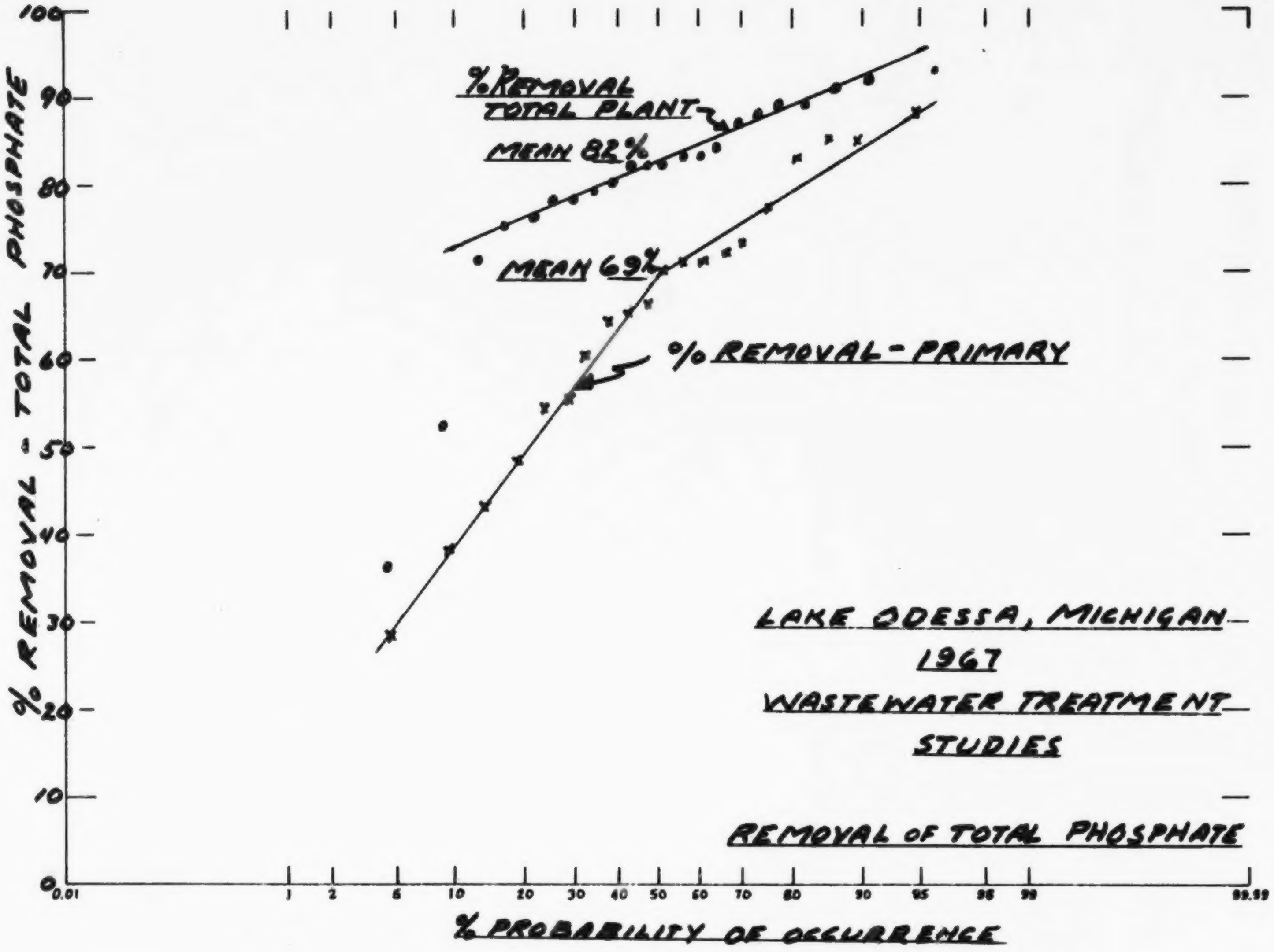


Fig V


% REMOVAL - TOTAL PHOSPHATE
100
90
80
70
60
50
40
30
20
10
0
0.01
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.99
% PROBABILITY OF OCCURRENCE
% REMOVAL TOTAL PLANT
MEAN 82%
MEAN 69%
% REMOVAL - PRIMARY
LAKE ODESSA, MICHIGAN
1967
WASTEWATER TREATMENT
STUDIES
REMOVAL OF TOTAL PHOSPHATE

LAKE ODESSA, MICHIGAN
1967
WASTEWATER TREATMENT STUDIES
TOTAL PHOSPHATES

FIG VI

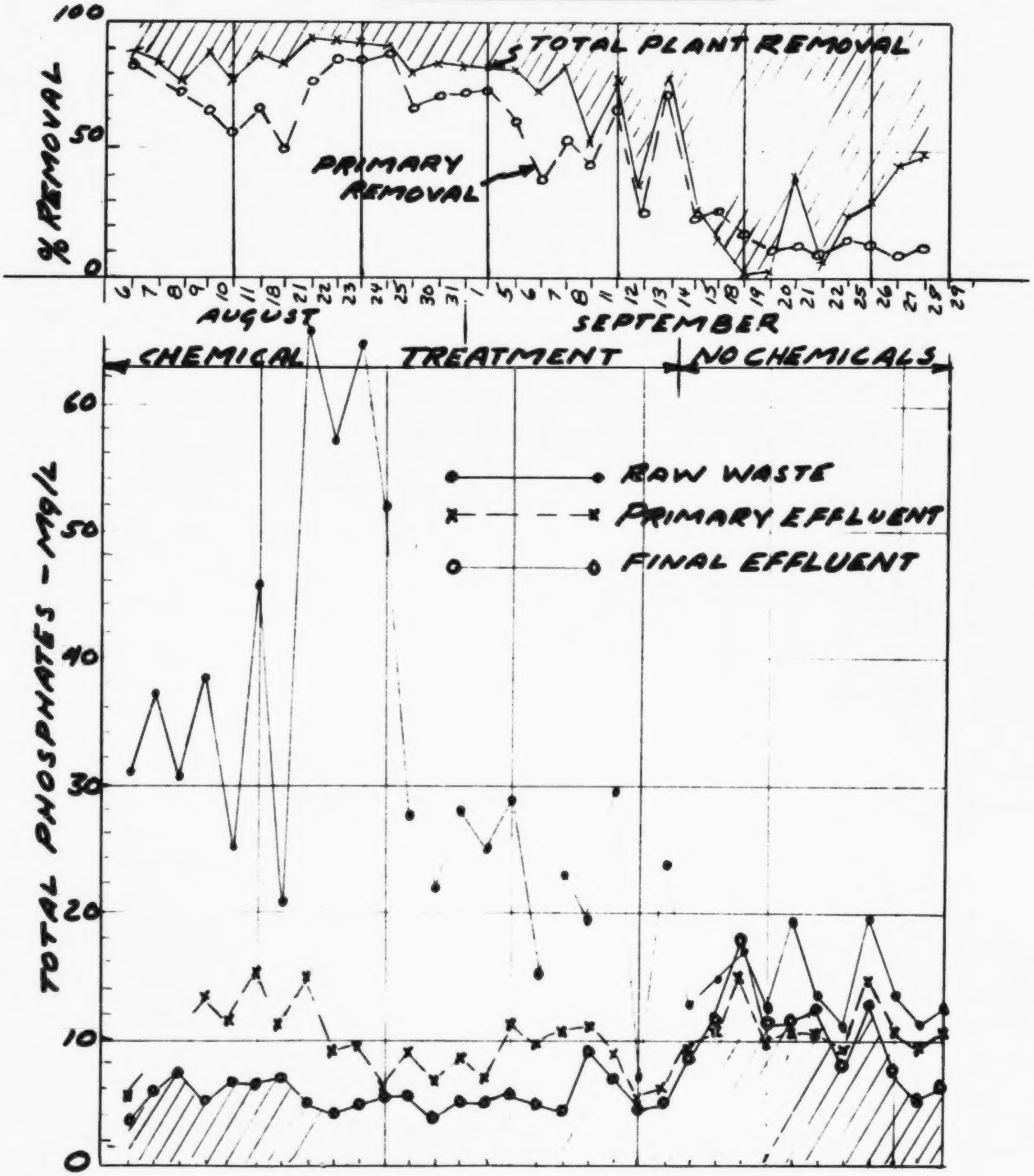


Table 2

LAKE ODESSA, MICHIGAN
1967
WASTEWATER TREATMENT STUDIES

SLUDGE DIGESTION DATA

Year	April		May		June		July		August		September		October	
	'66	'67	'66	'67	'66	'67	'66	'67	'66	'67	'66	'67	'66	'67
Gas Produced (100 Ft.^{3}/day)	18	15	14	16	24	30	31	22	20	23	29	35	34	24
Volatile Solids lbs/day	260	270	170	170	180	320	400	720	290	350	480	550	550	390
Volatile Solids lbs/day/100 Ft.^{3}	19.0	19.7	12.4	12.4	13.1	23.4	29.2	52.5	21.2	25.5	35.0	40.2	40.2	28.4
Temperature °F	91	92	92	92	---	92	92	92	92	91	92	91	90	90
Gas Produced per pound of Volatile Solids	6.9	5.6	8.2	9.4	13.9	9.4	7.8	3.1*	6.9	6.6	6.0	6.4	6.2	6.2
pH				6.8		6.5		6.1		7.0		6.4		6.7

* Large withdrawal of digested sludge in mid-July.

OBSERVATIONS DURING CHEMICAL TREATMENT

1. Percent phosphate removal followed a general pattern similar to suspended solids removal.

2. Percent phosphate removal appeared to be independent of the flow rate and raw suspended solids concentration.

3. Percent phosphate removal appears to be independent of the raw phosphate concentration.

4. Removal of suspended solids was consistently in the range of 83% to 90%, even though raw waste suspended solids concentrations varied greatly from day to day with extreme values ranging from less than 300 mg/l to more than 900 mg/l. The mean value of 89% represents significant improvement over the mean value of 78% removal of suspended solids attained without chemical treatment.

5. Percent BOD removal followed much the same pattern as suspended solids removal.

6. During the chemical treatment period, suspended solids and BOD concentrations were much more uniform in the treated waste than noted during the period when chemical treatment was not used.

7. No deterioration in sludge digestion was observed during or following the chemical treatment period as determined by common parameters such as gas produced per unit weight of volatile solids and pH. Further, a decrease in both total and orthophosphate concentrations in the digester supernatent liquor was observed during and immediately following the chemical treatment period.

8. At the conclusion of the chemical treatment period, an analysis of the digester sludge by X-ray defraction technique, revealed the presence of a high concentration of ferrous phosphate [Fe_3 (PO_4) · $8H_2O$], a phosphate rock commonly known as "Vivianite". It appears that this is the insoluble product formed when ferrous iron is mixed with raw sewage.

CONCLUSIONS

1. Bench scale studies demonstrated that thorough mixing of ferrous iron with Lake Odessa raw waste water for a period of 1 minute or less forms an insoluble product with little or no measurable orthophosphate and that total phosphate removal from the wastes in the range of 80% to 90% or higher may be attained by the addition of alkalinity and anionic polymers with gentle flocculation followed by a short period of sedimentation.

2. Plant scale studies demonstrated that removal of 73% to 95% of total phosphates, removal of 83% to 95% of suspended solids and removal of 72% to 95% of BOD can readily be achieved on the Lake Odessa waste water with existing treatment facilities equipped with chemical feeding even in the absence of any mixing and flocculation facilities.

3. Mixing and flocculating achieved were much less than required for maximum removal of total phosphates. The installation of facilities and equipment for these purposes may be expected to increase substantially the effectiveness of removal of total phosphates.

4. The return of digester liquor to the plant process under the chemical treatment regime described above should have no adverse affect upon the removal of total phosphates.

2736

APPENDIX H

INDUSTRIAL SURFACE WATER DISCHARGES
IN
THE LAKE MICHIGAN BASIN

TABLE I

DIRECT INDUSTRIAL DISCHARGES TO LAKE MICHIGAN

	Company Name	Product	Location	Treatment	Discharge Characteristics after Treatment			1967 Pollution Status Rating	Date of Order of Determination	Remarks
					Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day			
1.	Bay Street Steam Plant	Electricity	Traverse City							
2.	Cherry Growers, Inc.	Canning products	Suttons Bay	Screening	0.8	No Data Available				Seasonal operation
3.	Consumers Power Company	Electricity	Port Sheldon	Temperature control	175	No Data Available		A		
4.	Consumers Power Company	Electricity	Big Rock Point					A	November 1, 1960	Annual reports submitted on radioactive content of effluent
5.	Dow Chemical Company	Chemicals	Ludington		1.0		1,000	A		Brine wastes to Lake Michigan
6.	E. I. duPont de Nemours and Company	Synthetic rubber, freon acetylene	Montague	Septic tank coagulation, sedimentation Disc. 1500' off shore	[illegible]	[illegible]		A	June 25, 1964	
7.	Frigid Foods, Inc.	Canned cherries	Suttons Bay	Screening, city sewer	- - No Data Available - -			A	Decmeber 20, 1963	
8.	Inland Lime and Stone Company, Division Indiana Steel Company	Limestone and wash aggregate	Gulliver	Septic tank and settling basins	0.168		40.6 (8 hours)	A		
9.	Leelanau Fruit Company	Processed cherries	Suttons Bay	Vibrating screens and chlorination	- - No Data Available - -			B	June 26, 1963	
10.	Manistique Pulp and Paper Company	Paper	Manistique	City sewer, save-all, ponds	2.028	2,729*	16,572*	D_c	March 26, 1964	*Reflects loading for old system
11.	Medusa Portland Cement,	Cement	Charlevoix	Package treatment plant	- - No Data Available - -				April 28, 1966	New plant
12.	Morgan McCool	Food products	Traverse City	Screening	.547	1,866	109	E		Plans to relocate to off-water location
13.	Northport Cherry Factory	Canned cherries	Northport	Vibrating screens screens	- - No Data Available - -			A		
14.	Packaging Corporation of America	Paper board	Filer City	Settling	10.0	20,000	[illegible]	B_s	September 24, 1959	
15.	Penn-Dixie Cement Corporation	Cement	Petoskey	Septic tank, settling ponds	- - No Data Available - -			A		
16.	U.P. Power Company	Electricity	Escanaba	- - - - - - No Data Available - - - - - -				A		Cooling water [illegible]

TABLE 2

INDUSTRIAL SURFACE WATER DISCHARGES IN THE LAKE MICHIGAN BASIN 1967

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment			1967 Pollution Status Rating	Date of Order of Determination	Remarks
					Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day			
UPPER PENINSULA										
1. Menominee River Basin										
American Can Company, Menominee Mill	Wax paper	Menominee	Menominee River	Pederson & vacuum disc save-all	[illegible]	[illegible]	[illegible]			Additional control facilities being installed
Daggett Cheese Company	Cheese	Daggett	Little Cedar River	Septic tank, whey hauled by floor wash to swamp	[illegible]			A		
Hanna Mining Company (Homer-Wauseca)	Mining iron ore	Iron River	Iron River	Septic tank, lagoon for mine drainage	3.46	---	3,920	A		
Hanna Mining Company (Groveland Mine)	Mining iron ore	Randville	Pine Creek	Lagoons	[illegible]			A	March 27 & 28, 1958	
Inland Steel Company	Mining iron ore	Iron River	Iron River	Septic tank, lagoon for acid mine drainage	[illegible]		252	B		
Palestine Cheese Company	Cheese	Stephenson	Little Cedar River	Septic tank, haul whey	0.02			A		
Scott Paper Company	Gr. wood and pulp	Menominee	Menominee River	Side hill save-alls	[illegible]			A		<1% fiber loss
White House Milk Company	Butter and Powdered Milk	Stephenson	Little Cedar River	Comb. waste secondary treatment, trickling filter	[illegible]	[illegible]	[illegible]	A	January 28, 1959	
2. Cedar River Basin										
No major industries located in the basin										
3. Ford River Basin										
No major industries located in the basin										
4. Escanaba River Basin										
Mead Corporation, Escanaba Division	Coated paper	Escanaba	Escanaba River	Secondary, trickling filter, Pederson save-all	[illegible]	[illegible]	30,600	E_S		
5. Days River Basin										
No major industries located in the basin										
6. Rapid River Basin										
Michigan Milk Producers Association, Rapid River Division	Milk Products	Rapid River	Rapid River	Septic tank, haul whey				A	October 24, 1950	
7. Whitefish River Basin										
No major industries located in the basin										
8. Sturgeon River Basin										
No major industries located in the basin										
9. Manistique River Basin										
No major industries located in the basin										

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day	1967 Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA										
10. Pine River Basin										
East Jordan Canning Company	Vegetables and fruit	East Jordan	Jordan River	City sewer, lagoons				E		
Howes Leather Company, Inc.	Tannery	Boyne City	Lake Charlevoix	Primary settling	0.500	1,800	3,000	E	September 29, 1954	
Northern Michigan Electric Co-op	Power	Advance	Lake Charlevoix	Settling lagoon for fly ash				B_{pc}	September 29, 1965	
11. Elk River Basin										
Columbia Fruit Division, Michigan Fruit Canners, Inc.	Vegetable canning	Ellsworth	Intermediate Lake	Spray irrigation, vibrating screens	.569	1,713	3,037	A		
Elk Rapids Packing Company	Cherry canning	Elk Rapids	Elk Lake	Screening and chlorination	.500	800	150	B_s		Seasonal operation
Haas Foods, Inc.	Vegetable canning	Central Lake	Intermediate Lake	Rotary screen				A_s		
Lamina Tool and Die Corporation	Plating	Bellaire	Intermediate Lake and Cedar River	Batch treatment of cyanide				A		
12. Boardman River Basin										
Chef Pierre, Inc.	Pie	Traverse City	Boardman Lake	Septic tank, dry well				A		
Morgan-McCool, Inc.	Food Products	Traverse City	Boardman River - Grand Traverse Bay	Screening				E	March 30, 1966	
Parsons Corporation	Tube fabrication	Traverse City	Mitchell Creek	Settling lagoon				B	August 29, 1963	
Traverse City Canning Company	Canned fruit	Traverse City	Boardman River	Screening	.547	1,866	109	E		
13. Betsie River Basin										
Elberta Packing Company	Canned fruit	Elberta	Betsie Lake	Screening				B		
Pet, Inc.	Frozen cherries	Frankfort	Betsie Lake	Screening	0.420	760	150			
Pet Milk Company, Pet-Ritz Foods Division	Pies, apple and cherry	Frankfort	Betsie Lake	Screening	.600	930	235	D		

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment			1967 Pollution Status Rating	Date of Order of Determination	Remarks
					Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day			
LOWER PENINSULA CONTINUED										
14. Manistee River Basin										
Great Lakes Chemical Corporation	Bromine	Filer City	Manistee Lake	Septic tank, brine wells	0.423	Negligible	4,500		April 25, 1957	
Hardy Salt Company	Salt	Manistee	Manistee Lake	Settling lagoon	8.0			P		
Michigan Chemical Corporation	Bromine chemicals	East Lake	Manistee Lake	Condensor	0.120	Negligible	17			
Morton Salt and Chemical Company	Salt, magnesium, bromine	Manistee	Manistee Lake	Eductors	15	Negligible	19,000		April 30, 1959	
Packaging Corporation of America, American Box Board Division	Paper board	Filer City	Manistee Lake	Settling lagoons	5.00	2,000	5,000	A_s	September 24, 1959	
			Lake Michigan	Settling lagoons	10.00	20,000	13,500	B_s		
15. Big Sable River Basin										
- - - - - No major industries located in the basin - - - - -										
16. Lincoln River Basin										
- - - - - No major industries located in the basin - - - - -										
17. Pere Marquette River Basin										
Dow Chemical Company	Chemicals	Ludington	Lake Michigan and Pere Marquette River	Clarifier, brine to Lake Michigan not included			7,000	A	May 22, 1957	
					44.5	Negligible	8,000	A		
Harbison-Walker Refractories Company	Magnesite	Ludington	Pere Marquette River	Clarifiers, coagulant acids	5.3	Negligible	500	B	March 23, 1961	
Sanders Meat Packing Company	Meat Packing	Custer	Black River	Lagoon	- - No Data Available - -			D		
Stokely-Van Camp, Inc.	Cannery	Scottville	Pere Marquette River	Screening and chlorination	0.500	300	475	A	May 24, 1956	Seasonal
18. Pentwater River Basin										
- - - - - No major industries located in the basin - - - - -										
19. White River Basin										
Hooker Chemical Company	Chemical Cl_2 Caustic HCL	Montague	White Lake	Sedimentation, sand filtration, chlorination	900		3,000	A	June 28, 1956	
Misco Precision Casting Company	Metal Castings	Whitehall	White Lake	Sedimentation traps	- - No Data Available - -			C		
Whitehall Leather Company, Division of Genesco	Tanning	Whitehall	White Lake	Lagoon to lake	1.2	2,100	608	B_{sc}		

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment Flow MGD	 5-day BOD lbs/day	 Suspended Solids lbs/day	1967 Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA CONTINUED										
20. Muskegon River Basin										
Brooks and Perkins, Inc., Cadillac Manufacturing Division	Aluminum sheet preparation	Cadillac	Clam River	Ion exchange	- - No Data Available - -			B		
Campbell, Wyant and Cannon Foundry Company	Castings	Muskegon	Ruddiman Drain	Oil recovery	- - No Data Available - -			A		
Central Concrete Products Company	Washed gravel	Big Rapids	Muskegon River	Settling ponds	- - No Data Available - -			A		
Consumers Power Company, B.C. Cobb Plant	Electric power	Muskegon	Muskegon River	Settling lagoons for sludge and fly ash	450	No Data Available				
Continental Motors Corporation, Downtown	Auto engines	Muskegon	Muskegon Lake	Oil separator	0.81	130	450	D_{pc}		
Continental Motors Corporation, Getty Street Plant	Auto engines	Muskegon	Muskegon River	CN and chrome treatment, oil separation, acid neutralizing	0.46	38	196	A		
Denham Manufacturing Company	Electroplating	Big Rapids	Muskegon River	Cr treatment	.0916	No Data Available			May 24, 1956	
Evart Products Company		Evart	Twin Creek	Cooling water	- - No Data Available - -			B		
Gerber Products Company	Baby food	Fremont	Darling Creek and Fremont Lake	Spray irrigation, cooling water to stream	1.0	No Data Available		A		
H. J. Heinz Company	Pickles	Lakeview	Tamarack Lake	Screening	- - No Data Available - -					
Kaydon Engineering Corporation	Bearing	Muskogon	South Br. Ruddiman Creek	Clarifiers	.270	9	119	E_{ps}	October 27, 1966	
Lakeway Chemicals, Inc.	Alcohol base detergents and dye intermedias	Muskegon	Black River and Mona Lake	Seepage lagoons	0.344	700	7,500	B_s	May 24, 1962	
Liberty Dairy Company	Bottling plant	Evart	Muskegon River	Wash and cooling water	0.171	161	143		August 24, 1966	New plant
Naph-Sol Refining Company	Petroleum refining	North Muskegon	Muskegon River	API separator and lagoon	5.0	175	405	A	July 24, 1958	
Ott Chemical Company		Muskegon	Little Bear Creek	Seepage lagoons	.4175	1,045		E [illegible]	August [illegible], 1967	New treatment facilities under construction
Paris Gravel Company	Washed sand and gravel	Big Rapids	Muskegon River	Settling ponds	- - No Data Available - -			A		

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment			1967 Pollution Status Rating	Date of Order of Determination	Remarks
					Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day			
LOWER PENINSULA CONTINUED										
20. Muskegon River Basin Continued										
Sealed Power Corporation	Auto parts	Muskegon Heights	Ruddiman Drain and Mona Lake	Reduction of chrome	- - No Data Available - -			D		
Speas Company	Apple juice	Fremont	Cole Drain, Brooks Creek and Fremont Lake	Cooling water to stream	1.12	No Data Available		A	July 26, 1961	
Wallace Stone Company	Washed stone and gravel	Hersey	Muskegon River	Settling ponds	- - No Data Available - -			B		
Warren, S. D., Company	Paper pulp	Muskegon	Muskegon Lake	Clarifiers, save-all, sludge lagoons	12.0	13,000	18,000	E	December 7, 1955	
21. Grand River Basin										
Allen Packing Company	Slaughter-packing	Charlotte	County farm drain	Lagoon	- - No Data Available - -			A		
American Motors Corporation, Kelvinator Division		Wyoming	Plaster Creek	Chemical treatment	- - No Data Available - -			A		
Amway Corporation	Home cleaning products	Ada	Grand River	Stabilization lagoons	.063	809	187	D	July 23, 1964	
A.S.P. and Manufacturing Company	Plating	Grand Haven	Grand River	Chemical precipitation neutralization	0.084	No Data Available		D		
Attwood Corporation	Cadmium plating	Lowell	Flat River	Cyanide and chrome reduction	0.20		54	E_s	December 15, 1960	
Automatic Spec. Plating Company	Plating	Grand Haven	Grand River	Lagoons	- - No Data Available - -				December 1, 1953	
Aunt Jane's Foods, Division of the Borden Company	Pickle processing	Edmore	Stoney Creek	Screening	.0242	74.7	29.8	E_p	June 28, 1967	New treatment facilities planned
Bissell, Inc.	Sheet metal parts fabrication	Walker	Indian Mill Creek	Settling tanks	0.03	20	16		April 24, 1958	
Sanitary sewage								A		
Industrial wastes								A		
Challenge Porcelain Company	Bathtubs	Grand Haven	Grand River	None	.090		25			
Cherry Growers, Inc.	Cherry canning	Bailey	Fish Creek	Seepage lagoon	- - No Data Available - -			D	March 25, 1965	
Clark Equipment Company	Machinery	Jackson	Grand River	Lagoon		12		D		Occasional loss of oil to river
Crystal Refining Company	Oil refining	Carson City	Fish Creek	Oil removal	0.043	3				

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment Flow MGD	 5-day BOD lbs/day	 Suspended Solids lbs/day	1967 Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA CONTINUED										
21. Grand River Basin Continued										
Detroit Gasket and Manufacturing Company, Extruded Metal Division	Extrusion and aluminum anodizing	Belding	Flat River	Phosphate and oil removal	.70	6.0	150	B		
Eagle Ottawa Leather Company	Hide tanning	Grand Haven	Grand River	Screening	1.4	16,000	24,000	Ecp	September 28, 1960	
Electro Chemical Finishing Company	Electro plating	Middleville	Thornapple River	Cyanide, chrome and other metal treatment, lagoons, neutralization	.300	No Data Available			April 27, 1967	
Federal Mogul	Lead, tin, copper plating	Greenville	Flat River	Chemical treatment, lagoons	0.3	No Data Available				
General Motors Corporation, Diesel Equipment Division	Metal manufacturing	Grand Rapids Wyoming	Grand River Plaster Creek	Cyanide and chrome reduction, settling ponds	- - No Data Available - - 2.120	 8		A D	 November 30, 1967	
General Motors Corporation, Oldsmobile Forge Division	Forgings	Lansing	Grand River	Oil removal	- - No Data Available - -			A		
General Motors Corporation, Oldsmobile Division	Crank shafts and connecting rods	Delta Township, Eaton County	Jenne Drain,	Chemical treatment lagoon	.072	2		A	February 24, 1960	
Gibson Refrigerator Company	Cooling Equipment	Greenville	Flat River	Lagoon	0.1	No Data Available		A		
Gibson Refrigerator Company	Cooling Equipment	Belding	Flat River	Oil separator	.04	No Data Available		B		
Grand Rapids Brass Company	Zinc die casting	Wyoming	Buck Creek	Cooling waters	- - No Data Available - -			B	March 25, 1965	
Hastings Aluminum Products, Inc.	Aluminum coating	Hastings	Fall Creek		- - No Data Available - -			A		
Hastings Manufacturing Company	Auto parts	Hastings	Thornapple River	Chrome and oil removal	.28	No Data Available		A	November 30, 1961	
Hilfinger Jackson Corporation	Zinc plating auto parts	Jackson	Grand River	Cooling and anodize rinse to river and phosphate recovery	0.24	15		B	May 22, 1957	
Hupp Corporation		Belding	Flat River	Oil separator	- - No Data Available - -					
Hudsonville Dairy		Hudsonville	Rush Creek to Grand River	Septic tank	0.33	20	35	D		
Indian Summer, Inc.	Apple juice and vinegar	Belding	Flat River	Settling pond	.418	1,500	589	B		
Jervis Corporation	Metal finishing	Grandville	Grand River	Chemical treatment of cyanides and chrome sedimentation	0.788	No Data Available		[illegible]		

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment: Flow MGD	Discharge Characteristics after Treatment: 5-day BOD lbs/day	Discharge Characteristics after Treatment: Suspended Solids lbs/day	1967 Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA CONTINUED										
21. Grand River Basin Continued										
Keeler Brass Company	Metal plating	Middleville	Thornapple River	Cyanide reduction, neutralization, sludge removal	- - No Data Available - -			A		
Kroeger Company	Warehouse office	Paris Township, Kent County	Plaster Creek	Activated sludge, chlorination	.41	1.2	51		July 26, 1956	
LeFere Forge and Machine Company	Truck hubs and gear blanks	Jackson	Grand River	Oil separator	.265	233	280	B		History of oil losses
Leslie Metal Arts Company, Inc.	Metal stamping	Paris Township, Kent County	Plaster Creek	Septic tank and underdrained sand filter, with chlorination	- - No Data Available - -			E	September 29, 1965	
Light Metals Corporation	Extrusions	Wyoming	Roy's Creek Drain	Chemical neutralization, sedimentation sludge lagoon	0.54		344	D_s	August 26, 1960	
Michigan Consolidated Gas Company	Gas compressor station	Six Lakes	First Lake at Six Lakes Drain	Cooling water	4.32	No Data Available		A	March 24, 1955	
Michigan Milk Producers Association	Milk plant	Ovid	Maple River	Spray irrigation	0.5	15	8.87	A	November 29, 1962	Cooling water to stream
Municipal Power Plant	Electric Power	Grand Haven	Grand River	Cooling water	0.34	No Data Available				
National Fruit Products Company, Inc.	Cherry process	Kent City	Ball Creek	Stabilization, ground seepage and irrigation	0.1	No Data Available		A		Seasonal discharge
Nelson Metal Products, Division of Midland Ross Corporation	Die cast plant	Grandville	Buck Creek	None	- - No Data Available - -			B	July 28, 1966	
New York Central RR		Jackson	Grand River	Oil traps	0.07	No Data Available		A		
Ore-Ida Foods, Inc.	Fruit and vegetable freezing	Greenville	Dickerson Creek	Primary clarifier, lagoons, spray irrigation	- - No Data Available - -			B	September 23, 1964	
Owens-Illinois Glass Company	Glass	Charlotte	Butternut Creek	Sedimentation	- - No Data Available - -			B		
Packaging Corporation of America, American Box Board Division	Corrugated boxes	Grandville	Roy's Creek Drain	None	- - No Data Available - -			B		
Packaging Corporation of America, American Box Board Division	Paper cartons	Grand Rapids	Grand River	Save-alls	2.5	3,000	6,500	B		

					Discharge Characteristics after Treatment			1967		
Company Name	Product	Location	Receiving Stream	Treatment Provided	Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day	Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA CONTINUED										
21. Grand River Basin Continued										
Pet Milk Company	Condensed milk	Coopersville	Deer Creek	In-plant controls	- - No Data Available - -			B		
Pittsburg Forging Company	Forging	Jackson	Grand River	Oil skimmer	0.07	No Data Available		A		
Ranny Refrigeration	Refrigerators	Greenville	Flat River	Lagoons	0.015	13				
Rockford Paper Mills, Inc.	Box board	Childsdale	Rogue River	Clarifiers	1.0	1,200	4,000	B		
Samary Food Products	Fruit processing	Coopersville	Deer Creek	Spray irrigation and screening	0.03	300		A	July 29, 1965	Does not run every year
Saranac Manufacturing Company	Plating and buffing	Saranac	Grand River	Cyanide and chrome treatment, lagoon seepage	.150	No Data Available			July 29, 1954	
Swanson Pickle Company	Pickle brining	Ravenna	Crockery Creek	Brine lagoon	- - No Data Available - -			B_c		
Store-A-Way, Inc.	Meat processing	DeWitt	Lookingglass River	In-plant controls	.001	10	20	A	January 26, 1961	
Super Food Service	Food warehouse and office	Grand Rapids	Plaster Creek	Activated sludge	.0008	1.24	3.90		November 30, 1961	
Trailmobile	Washing trailers and tank trucks	Wyoming	County Drain to Plaster Creek	Grit and grease removal	.001	No Data Available			June 22, 1961	
Universal Metal Products	Metal products	Saranac	Grand River	None	.200		35	C		65 lbs/day phosphate
Utilex Corporation	Plating	Fowlerville	Red Cedar River	Cyanide and chrome settling lagoon, oil skimmer	.350	[illegible]	120	B	January 28, 1958	
White Products Corporation	Water heaters, water softeners and plumbing ware	Middleville	Thornapple River	Cooling water	0.01	6	6.76	A	October 26, 1961	
Withrow Pickle Company		Sand Lake	Round Lake		- - No Data Available - -			C		
Wolverine Finishes Corporation		Wyoming	Plaster Creek	Chemical precipitation	- - No Data Available - -			B_c		
Wolverine World Wide, Inc.	Shoes, tanning	Rockford	Rogue River	Screening, clarifiers, vacuum filter	.600	2,000	1,000	D_a	March 26, 1952	

					Discharge Characteristics after Treatment					
Company Name	Product	Location	Receiving Stream	Treatment Provided	Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day	1967 Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA CONTINUED										
22. Black River Basin										
Bohn Aluminum Corporation	Extrusion aluminum	Holland	Wildwood Drain to Lake Macatawa	Nickel recovery and neutralization	.180	23	55	D_c	October 25, 1956	
DeWitts Poultry Processing	Poultry processing	Zeeland	Black River	Septic tank, screening, and sand filters	0.106	3.1	8.0			
Donnelly Mirrors	Glass mirrors	Holland	Lake Macatawa	Lagoons	.098	103	294	E_s		
Hart and Cooley Manufacturing Company	Furnace supplies	Holland	Black River via County Drain	Septic tank, stabilization ponds	.040	34	21	E_p	April 23, 1952	
H. J. Heinz and Company	Canning, pickles, vinegar and cider	Holland	Lake Macatawa	Screening	.850	2,225	1,000	E		
Holland Suco Color Company	Organic colors and chemicals	Holland	Lake Macatawa	Clarifier	.800	1,700	400	D	May 27, 1965	
Holland Die Casting, Inc.	Zinc castings	Holland	Black River	Neutralization lagoon	.223	59	48	B	March 25, 1959	
James DeYoung Generating Station	Electric power	Holland	Lake Macatawa	Cooling water	- - No Data Available - -				June 28, 1967	
Keeler Brass Company		Zeeland	Brower Drain	Lagoon and neutralization of acid	.015	4	2			
Meade, Johnson and Company	Drugs	Zeeland	Black River	Activated sludge	.182	90	197	B		
Miles Laboratories, Inc.	Drugs	Zeeland	Hunter Creek	Lagoon	1.17	107	60	B		
Parke, Davis and Company	Synthetic drugs, chemicals	Holland	Lake Macatawa	Primary settling and Cl_2 oxidation	7.2	144		A	February 24, 1960	
								A		
23. Kalamazoo River Basin										
Albion Malleable Iron Company	Iron castings	Albion	Kalamazoo River	Dust collection, settling	0.780		4,511	E_p		
Allegan Metal Finishing Company	Electroplating	Allegan	Kalamazoo River	Cyanide and metal treatment	.007	No Data Available		D	March 28, 1963	Ground water contamination
Allied Paper Corporation, Monarch Division	Paper	Kalamazoo	Portage Creek	Clarifier	2.0	400	300		October 24, 1951	
Solids								A		
Oxygen demand wastes								A		
Allied Paper Corporation, Bryant Division	Paper	Kalamazoo	Portage Creek	Clarifier	4.0	8,000	7,000			
Solids								A		
Oxygen demand wastes								E		
Allied Paper Corporation, King Division	Paper	Kalamazoo	Kalamazoo River	Clarifier	.8	900	400		October 24, 1951	
Solids								[illegible]		
Oxygen demand wastes								[illegible]		

LOWER PENINSULA CONTINUED

23. Kalamazoo River Basin Continued

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment			1967 Pollution Status Rating	Date of Order of Determination	Remarks
					Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day			
Aluminum Extrusions, Inc.	Extrudes aluminum	Charlotte	Battle Creek River	Lagoons	- - No Data Available - -			E_{sp}		
American Aggregate Corporation	Gravel washing	Kalamazoo	Kalamazoo River	Sedimentation	- - No Data Available - -			A		
Brown Paper Company Mill 1	Parchment and wax paper	Parchment	Kalamazoo River	Lagoon	- - No Data Available - -				October 24, 1951	
Solids								A		
Oxygen demand wastes								A		
Brown Paper Company Mill 2	Parchment and wax paper	Parchment	Kalamazoo River	Lagoon	- - No Data Available - -				October 24, 195[illegible]	
Solids								A		
Oxygen demand wastes								A		
Brunswick Corporation	Furniture	Kalamazoo	Allen Creek	Sedimentation, oil separator	0.252		[illegible]	E	January 21, 1960	
Chase Manufacturing, Division of Gulf and Western (Scotts, Inc.)		Douglas	Kalamazoo River	Cyanide and chrome treatment, lagoon	- - No Data Available - -			B		
Clark Equipment Company	Fork lift trucks	Battle Creek	Kalamazoo River	Oil removal	- - No Data Available - -			E		
Consumers Power Company	Electric power	Battle Creek	Battle Creek River	Cooling water	- - No Data Available - -					
Consumers Power Company	Electric power	Comstock	Kalamazoo River	Cooling water	- - No Data Available - -			B_c		
Corning Glass Works	Glass, TV tubes	Albion	Kalamazoo River	Clarifier, neutralization	0.03	No Data Available		A	February 23, 1966	
Culligan Soft Water, Inc.	Water softening	Battle Creek	Kalamazoo River	Controlled discharge	.006	No Data Available			September 29, 195[illegible]	Restricted to 1000# Cl/day
DeKleine Packing Company	Pickles and relish	Bentheim	Black Creek to Big Rabbit River	Septic tank, screen	- - No Data Available - -				June 27, 1957	
Eaton, Yale and Towne, Inc., Marshall Division	Gears	Marshall	Kalamazoo River	Lagoons	0.144	[illegible]		D_p		
Fresh-Pak Corporation	Canning	Martin	Gun River	None	0.20	[illegible]	30	E		
General Foods Corporation	Cereal	Battle Creek	Battle Creek River	Cooling water	- - No Data Available - -			E		Occasional cereal losses
Grand Trunk Railroad Company	Repair of equipment	Battle Creek	Battle Creek River	Oil separator	.364	No Data Available		E_s		
Kellogg Company		Battle Creek	Battle Creek River	Cooling water	- - No Data Available - -			E		Occasional cereal losses
Lakeside Refining Company	Fuel oil	Kalamazoo	Allen Creek	Oil floatation, skimming, recovery	- - No Data Available - -					
Lorton Products Company	Rendering, feed and fertilizer products	East Saugatuck	Kalamazoo River	Septic tank, settling, irrigation	[illegible]	--	--	A	February 24, 1955	
Menasha Corporation, Paper Board Division	Paper Board	Otsego	Kalamazoo River	Save-all	[illegible]	[illegible]	12,000		October 31, 1963	
Solids								A		
Oxygen demand wastes								B_c		
Michigan Fruit Canners, Inc.	Fruit and vegetable canning	Fennville	Mann Creek via County Drain	Irrigation	.500	2,300	[illegible]	[illegible]		
Murray Packing Company	Slaughter and packing	Plainwell	Kalamazoo River	Lagoons	.010	220		E_c	September 29, 1965	

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment			1967 Pollution Status Rating	Date of Order of Determination	Remarks
					Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day			
LOWER PENINSULA CONTINUED										
23. Kalamazoo River Basin Continued										
New York Airbrake Company	Pumps, motors, valves	Galesburg	Kalamazoo River	Trickling filter, oil floatation and removal	.192	7.13	5.58		September 28, 1955	
Industrial wastes								A		
Sanitary sewage								A		
North American Extrusions Corporation	Aluminum tubing and anodizing	Parchment	Travis Creek	Septic tank neutraliza-tion, lagoons	.7		124	E	October 30, 1957	
Pet Milk Company	Dairy products	Wayland	Rabbit River	In-plant controls	.049	145	27	A		
Plainwell Canning Company	Canned fruit	Plainwell	Kalamazoo River	Seasonal spray irrigation	.0436	494		B		
Ralston Purina Company	Dog and cat food	Battle Creek	Battle Creek River		- - No Data Available - -			B		
Shakespeare Corporation	Electro-plating	Kalamazoo	Kalamazoo River	Plating recovery system	- - No Data Available - -			A	February 23, 1966	
Union Steel Products Company	Wire products	Albion	Kalamazoo River	Complete treatment for plating waste	- - No Data Available - -			B_c		
Valley Metal Products Company	Aluminum extrusion	Plainwell	Kalamazoo River	Neutraliza-tion, lagoon	- - No Data Available - -			B		
Waldorf Paper Products Company, Mac Sim Bar Division	Paper board	Otsego	Kalamazoo River	Clarifier and stabili-zation lagoons	1.1	2,035	940			
Solids								A		
Oxygen demand wastes								B		
Weyerhaeuser Company	Paper	Plainwell	Kalamazoo River	Activated sludge	1.75	3,820	2,650			
Solids								B		
Oxygen demand wastes								D_c		
24. Black River Basin										
Du-well Decorative Company	Decora-tive Metal	Bangor	Black River	Complete plating waste treatment	0.20		192	A		
Michigan Fruit Canners, Inc.	Fruit products	South Haven	Black River	Screening	0.447	2,314	403.4			
South Haven Chemical Company		South Haven	Black River	Controlled discharge	- - No Data Available - -			A		
25. Paw Paw River Basin										
Burnette Farms Packing Company	Canning vegetables and fruits	Lawrence	Brush Creek	Septic tank and spray irrigation	0.050	300		B		
Clark Equipment Company		Benton Township, Berrien County	Ox Creek	Cooling water	.080	No Data Available -		A		
Coloma Cooperative Canning Company	Canning	Coloma	Paw Paw River	Screening, irrigation, lagoon	- - No Data Available - -					
Hartford Metal Protection Company	Chrome plated parts	Hartford	Pine Creek	Complete plating waste treatment	.071		94.0			

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment: Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day	1967 Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA CONTINUED										
25. Paw Paw River Basin Continued										
Honee Bear Canning Company	Fruit products	Lawton	Townline Drain	Lagoons	- - No Data Available - -			A	July 28, 1960	
Midwest Timer Service, Inc.	Chrome plating	Hagar Township, Berrien County	Pratt Drain	Lagoons	- - No Data Available - -			A	July 28, 1960	
Millburg Fruit Exchange (Kay Foods)	Canning	Millburg	Blue Creek	Oxidation ponds	- - No Data Available - -			B		
Murch A. F. and Company	Grape and cherry juice	Paw Paw	Jennings Drain	Septic tank, spray irrigation	0.72	[illegible]		D	September 21, 1961	
Pearl Grange Packing Company		Benton Township, Berrien County	Yore and Stoeffer Drain	Septic tank, lagoon, spray irrigation	.025	400		A		
Pet Milk Company, Musselman-Dwan Division	Canning vegetables and fruits	Paw Paw	Paw Paw River	Screening, spray irrigation	0.10	740	335	E		
Quality Frozen Foods		Lawrence	Paw Paw River	Screening	- - No Data Available - -			B		
Sill Farms	Cherry processing	Lawrence	Brush Creek	Screening, spray irrigation	- - No Data Available - -			B		
Watervliet Paper Company	Paper	Watervliet	Paw Paw River	Save-alls	1.75	3,0[illegible]	12,[illegible]	A		
Welch Grape Juice Company	Juices, jams	Lawton	Lawton Creek	Screening, spray irrigation	0.8	1,000		A		
26. St. Joseph River Basin										
Alpha, Inc.	Metal plating and tubing	Eau Claire	Extension Drain and other waters	Chemical treatment, lagoon	1.6	89	1,000	[illegible]	February 23, 1966	
American International Aluminum	Aluminum extrusions	Coldwater	St. Joseph River	Ponds and skimming devices	0.05[illegible]		29			
Bendix Corporation	Gray iron foundry	St. Joseph	Hickory Creek	Cooling water	- - No Data Available - -			A	March 30, 1966	
Clark Equipment Company		Buchanan	McCoy Creek	Oil trap	0.100	380				
Coldwater Rendering Works	Meat packing	Coldwater	Coldwater Lake	Sedimentation	0.75	131	107			
Eau Claire Packing Company	Canning	Eau Claire	Farmers Creek	Screening, sedimentation lagoon, spray irrigation	0.698	48	30	A		
French Paper Company	Paper manufacturing	Niles	St. Joseph River	Save-all	0.811	2,820	3,620	E		
Industrial Rubber Goods Company	Rubber goods and body trim	St. Joseph	Abraham Drain	Septic tank and Cl_2	- - No Data Available -					

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment			1967 Pollution Status Rating	Date of Order of Determination	Remarks
					Flow MGD	5-day BOD lbs/day	Suspended Solids lbs/day			
LOWER PENINSULA CONTINUED										
26. St. Joseph River Basin Continued										
Kawneer Company Plant No. 1	Building products	Niles	St. Joseph River	Septic tank, chrome treatment	0.612	50		D_p	February 25, 1953	
Kingston Products Corporation, Douglas Manufacturing Division	Electro-plating	Bronson	County Drain	City and chemical treatment of plating wastes	0.158	100		A	March 21, 1950	
Kirsch Manufacturing Company	Metal industry	Sturgis	Fawn River	Oil removal	[illegible]	4	900	A		
Kirsch Manufacturing Company	Metal industry	White Pigeon	White Pigeon Lake	None	0.7	8	204			
Lamb-Knit Goods		Colon	Sturgeon Lake	Septic tank	- - No Data Available - -			D_p		
Michigan Mushroom Company	Mushrooms and asparagus	Niles	St. Joseph River	Vibrating screens	0.025	200		A		
Midland Wire Corporation	Electrical wire	Three Rivers	St. Joseph River	Cooling water, closed system	- - No Data Available - -			A	January 3, 1964	
Municipal Power Plant	Electri-city	Coldwater	Coldwater River	Cooling tower	- - No Data Available - -					
Quincy Products Company	Refrigera-tion coils	Quincy	Marble Lake via County Drain	Chemical treatment destruction of CN	.056	50	7.4	D_{sp}	May 28, 1958	
Research Molding and Film Company		Mendon	St. Joseph River	Oil trap, ponds	0.120	No Data Available		B		
Rudy Manufacturing Company	Heat exchangers	Dowagiac	Pine Lake Drain	cooling water to lagoons	0.305	4.1		A_p	December 3, 1964	
Schaefer Manufacturing Company	Electro-plating and anodizing	Union City	St. Joseph River	In-plant control	0.08	50		E_s		
Schmidt Packing Company	Meat packing	Niles	Dowagiac Creek	None	- - No Data Available - -			C		
Silver Mill Frozen Foods, Inc.	Fruit packing	Eau Claire	Farmers Creek	Lagoons	0.68	500	110	D_{cp}	January 21, 1966	
Simplicity Pattern Company, Inc.	Paper patterns	Niles	St. Joseph River via Lacey Creek	Save-all units	1.18	1,350	2,360	D_{ps}		Additional save-all units planned
Simpson-Lee Paper Company	Paper	Vicksburg	Gourdneck Creek	Sedimenta-tion with coagulation	4.21	2,306	2,692	B_s	December 5, 1957	
Stover Soft Water Service	Recharge water softeners	Berrien Springs	St. Joseph River	Controlled discharge	0.01	No Data Available			April 26, 1956	
United Food, Inc.	Canned and frozen food	Sodus	Pipestone Creek via County Drain	Screening, irrigation	- - No Data Available - -			B_{sp}		
Weyerhaeuser Company	Paper	White Pigeon	White Pigeon River	Floatation, save-all, clarifiers	2.0	4,200	5,000	B		
Whirlpool Corporation	Nickel plating	Benton Harbor	St. Joseph River	Chemical treatment and lagoons	0.144	No Data Available		A	September 23, 1964	

Company Name	Product	Location	Receiving Stream	Treatment Provided	Discharge Characteristics after Treatment: Flow MGD	Discharge Characteristics after Treatment: 5-day BOD lbs/day	Discharge Characteristics after Treatment: Suspended Solids lbs/day	1967 Pollution Status Rating	Date of Order of Determination	Remarks
LOWER PENINSULA CONTINUED										
Industries with Discharges in Minor Drainage Areas										
Bil-Mar Poultry	Poultry processing	Borcula	Pigeon River	Settling basins, lagoons				C	August 29, 1967	
Elk Rapids Packing Company	Fruit packing	Lake Leelanau	Lake Leelanau	Screening and chlorination	0.144			A	June 22, 1961	
Onekama Canning Company	Canning cherries	Onekama	Portage Lake	Screening				A		
Petoskey Plating Company	Auto parts	Petoskey	Bear River	Chemical treatment	0.047			B		
Smeltzer Packing Company	Cherries and apples	Benzonia	Herring Lake	Screening				A		

APPENDIX I

MUNICIPAL WASTE WATER DISCHARGES
IN
THE LAKE MICHIGAN BASIN

TABLE I

MICHIGAN'S
MUNICIPAL WASTE WATER DISCHARGE
INVENTORY
LAKE MICHIGAN BASIN

1. MENOMINEE (MICH.)

				Discharge Characteristics							
Community	Receiving Waters	Treatment Provided	Population (1964 est.)	5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
Alpha	Armstrong Creek	Primary ST	300	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.030	
Caspian	Iron River	Primary IT	1,490	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.150	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Crystal Falls	Paint River	None	2,200	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.220	Program in progress. Facilities to be in operation by June 30, 1969.
Gaastra	Iron River	Primary ST	600	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.060	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Iron Mountain - Kingsford	Menominee River	Primary	14,400	280	182	35	228	69	70	1.18	Final Order adopted November 21, 1950. Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968 #
Iron River	Iron River	Primary	3,300	136	97	30	161	76	45	0.30	Final Order adopted November 21, 1950. Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968 #
Menominee	Menominee River	Primary	11,400	89	61	27	107	50	48	1.89	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Mineral Hills	Iron River	Primary ST	300	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.030	Staff recommendations on adequacy of present treatment to be presented to WRC by March 1, 1968.
Norway	Menominee River	None	3,200	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.320	Order adopted August 29, 1967. Program in progress. Facilities to be in operation by July 1, 1968.
South Republic	Michigamme River	Primary ST	400	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.040	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Stambaugh	Iron River	Secondary AS	1,900	188	41	80	260	38	85	0.09	Final Order adopted November 21, 1950. Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968 #
Stephenson	Little Cedar River	Secondary TF	820	234	37	83	183	35	81	0.18	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Vulcan	Menominee River	Primary ST	450	- - - - - - - - - - -	- No Data Available -	- - - - - - - - - - -				0.045	Staff recommendations on adequacy of present treatment to be presented to WRC by March 1, 1968.

Note: # Designates Orders which have been confirmed by court action.
Designates Orders which are currently under court review.

Community	Receiving Waters	Treatment Provided	Population (1964 est.)	Discharge Characteristics						Flow MGD	Status and Abatement Action
				5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal		
2. BIG CEDAR											
Pinecrest Medicare Facility	Big Cedar River	Secondary TF	No Data Available								
3. FORD											
No Large Population Centers in Basin											
4. ESCANABA											
Palmer	Warner Creek	Primary ST	850	No Data Available						0.085	
5. DAYS											
Gladstone	Lake Michigan	Primary	5,400	230	158	29	260	110	56	0.67	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
6. RAPID											
Masonville	Rapid River	None	600	No Data Available						0.06	Conference held before WRC September 30, 1966. Corrective program underway
7. WHITEFISH											
No Large Population Centers in Basin											
8. STURGEON											
Sagola	West Branch Sturgeon	Primary ST	100	No Data Available						0.010	
9. MANISTIQUE											
Manistique	Manistique River	Primary	4,500	37	22	43	31	17	47	1.68	Final Order adopted October 24, 1950. *
10. PINE											
Boyne City	Lake Charlevoix	Primary	2,800	88	49	47	95	39	58	0.22	Final Order adopted September 23, 1952. *
Charlevoix	Pine River	Primary	2,800	217	130	40	202	64	61	0.38	
East Jordan	Lake Charlevoix	Primary	1,920	113	65	40	154	65	58	0.086	Final Order adopted July 26, 1950. *
11. ELK											
Bellaire	Intermediate River	None	700	No Data Available						0.069	Conference held before WRC December 16, 1966. Corrective program underway
Elk Rapids	Elk River	Primary	1,015	No Data Available						0.102	Final Order adopted May 25, 1950

Community	Receiving Waters	Treatment Provided	Population (1964 est.)	Discharge Characteristics 5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
12. BOARDMAN											
Kalkaska	Boardman River	Secondary L	1,320	- - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.137	
Traverse City	Boardman River	Primary	18,500	203	164	19	185	66	63	3.60	Signed a Stipulation for secondary treatment and phosphate removal. Plant scheduled for construction by December 31, 1970.
13. BETSIE											
Beulah	Crystal Lake	Primary IT	440	- - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.044	
Elberta	Betsie River	Primary	550	161	100	39	213	78	62	0.081	Order of Determination adopted August 22, 1950.
Frankfort	Betsie River	Primary	1,690	397	334	19	220	107	51	0.14	
14. MANISTEE											
Manistee	Manistee River	Primary	8,300	182	128	30	155	69	52	0.52	
Manton	Cedar and Manton Creeks	None	1,050	- - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.105	Conference held before WRC December 16, 1966. Corrective program underway
15. BIG SABLE											
- No Large Population Centers in Basin -											
16. LINCOLN											
- No Large Population Centers in Basin -											
17. PERE MARQUETTE											
Custer	Black Creek	None	365	- - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.037	Conference held before WRC December 16, 1966. Corrective program underway
Ludington	Pere Marquette River	Primary	9,000	77	39	48	93	63	48	1.76	
Scottville	Pere Marquette River	Secondary L	1,245	- - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.125	
18. PENTWATER											
Hart	Pentwater River	Secondary L	1,990	- - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.199	Final Order of Determination adopted September 26, 1963.
Pentwater	Pentwater River	Secondary L	1,030	- - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.103	
19. WHITE											
White Cloud	White River	Primary IT	1,000	270	97	64	190	38	80	0.46	
Whitehall	White River	Primary	2,800	162	110	31	160	58	63	0.21	

				Discharge Characteristics							
Community	Receiving Waters	Treatment Provided	Population (1964 est.)	5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
20. MUSKEGON											
Big Rapids	Muskegon River	Primary	10,100	218	98	48	229	92	55	0.60	Final Order adopted May 23, 1952.
Cadillac	Clam River	Secondary AS	10,300	208	30	85	232	52	77	0.95	Final Order adopted July 28, 1960. *
Evart	Muskegon River	Primary	1,775	70	29	59	71	48	32	0.28	
Fremont	Muskegon River	Secondary TF	3,400	513	15	97	224	27	88	0.338	
Howard City	Tamarack Creek	None	1,000	No Data Available						0.10	Final Order adopted January 21, 1966. **
Marion	Middle Branch River	None	900	No Data Available						0.09	Conference held before WRC December 16, 1966. Corrective program underway
Muskegon	Muskegon River	Primary	43,000	127	93	27	140	51	64	7.86	Preliminary studies underway for proposed advanced treatment needs.
Muskegon Heights	Muskegon River	Secondary AS	19,900	237	23	90	281	21	91	1.86	Final Order adopted January 24, 1950. *
Newaygo	Muskegon River	Primary	1,450	160	105	35	199	62	68	0.08	
North Muskegon	Muskegon River	Primary	4,000	230	163	31	191	127	33	0.27	
Reed City	Muskegon River	Primary	2,180	623	272	54	270	174	36	0.41	Order of Determination adopted July 26, 1950. Additonal treatment needs being investigated.
21. GRAND											
Ada Township (Ada)	Thornapple River	Primary ST	500	No Data Available						0.05	Conference held before WRC February 24, 1966. Corrective program underway
Alpine Township	York and Mill Creeks	None	5,000	No Data Available						0.50	Final Order adopted July 28, 1966. Corrective program underway
Ashley	Ashley Drain	None	410	No Data Available						0.04	Final Order adopted August 29, 1967. Corrective program underway
Belding	Flat River	Secondary L	5,000	No Data Available						0.50	
Byron Township, Kent County	Grand River	None		No Data Available							Conference held before WRC February 24, 1966. Corrective program underway
Caledonia	Thornapple River	Primary ST	740	No Data Available						0.074	Conference held before WRC February 24, 1966. Corrective program underway
Carson City	Fish Creek	None	1,200	No Data Available						0.12	Final Order adopted January 17, 1968. Plant to be in operation by June 1, 1969.
Casnovia	Bell Creek	None	371	No Data Available						0.037	Conference held before WRC February 24, 1966.

				Discharge Characteristics							
Community	Receiving Waters	Treatment Provided	Population (1964 est.)	5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
21. GRAND CONTINUED											
Cedar Springs	Cedar Creek	Secondary L	1,770	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.177	
Coopersville	Deer Creek	Secondary TF	1,580	225	73	68	203	72	65	0.21	Conference held with WRC February 24, 1966. Corrective program underway
Delhi Township	Grand River	Primary	5,000	288	127	56	304	87	71	0.19	
Delta Township	Grand River	Secondary AS	7,600	206	21	91	211	12	93	0.718	
DeWitt	Looking-glass River	Primary	1,240	260	190	27	352	136	55	0.053	Order of Determination adopted January 25, 1962.
DeWitt Township	Looking-glass River	None	7,600	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.76	Final Order adopted July 28, 1966. Facilities to be in operation by February 1, 1968.
Dimondale	Grand River	None	900	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.090	Final Order adopted January 19, 1967. Plant to be in operation by June 1, 1969.
Edmore	Stoney Creek	Secondary L	1,240	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.123	
East Lansing	Cedar River	Secondary AS	37,800	122	29	74	157	87	58	6.4	
Eaton Rapids	Grand River	Primary	4,300	357	234	34	291	145	49	0.27	Final Order adopted September 25, 1951 *
Fowler	Peet Creek	Secondary TF	850	561	59	89	245	37	85	0.085	
Fowlerville	Red Cedar River	Secondary L	1,670	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.167	
Gaines Township (Cutlerville)	Buck Creek	None	- - - - - - - - - - - - - - - No Data Available - - - - - - - - - - - - - - -								Conference held before WRC February 24, 1966. Corrective program underway
Gaines Township (Dutton)	Plaster Creek	None	- - - - - - - - - - - - - - - No Data Available - - - - - - - - - - - - - - -								Conference held before WRC February 24, 1966. Corrective program underway
Grand Haven	Grand River	Primary	11,700	154	71	51	128	56	54	1.91	
Grand Ledge	Grand River	Primary	5,500	199	111	43	233	86	62	0.48	
Grand Rapids	Grand River	Secondary AS	220,300	98	13	86	129	21	84	37.1	Order adopted November 22, 1949 *
Grandville	Grand River	Secondary AS	8,500	138	13	91	235	9	95	0.72	Final Order adopted July 26, 1961 *
Grant	Crockery Creek	Secondary TF	730	290	20	92	367	41	85	0.043	
Greenville	Flat River	Primary	7,200	187	118	36	204	74	63	1.05	
Hastings	Thorn-apple River	Primary	7,000	236	165	30	267	11[illegible]	[illegible]		

				Discharge Characteristics							
Community	Receiving Waters	Treatment Provided	Population (1964 est.)	5-day BOD Influent mg/1	5-day BOD Effluent mg/1	5-day BOD Effluent % Removal	Suspended Solids Influent mg/1	Suspended Solids Effluent mg/1	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
21. GRAND CONTINUED											
Hudsonville	Buttermilk Creek	None	2,600	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.26	Conference held before WRC February 24, 1966. Corrective program underway
Ionia	Grand River	Primary	6,750	90	59	35	136	72	47	1.20	
Jackson	Grand River	Secondary AS	48,500	108	8	93	206	16	92	9.07	Tertiary treatment program underway.
Kent City	Ball Creek	Secondary SF	620	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.062	
Kent County Airport	Plaster Creek	Secondary L	5,800	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.50	
Laingsburg	Looking-glass River	None	1,000	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.10	Conference held before WRC February 24, 1966. Final Order under consideration.
Lake Odessa	Little Thorn-apple River	Secondary TF	1,810	207	65	72	426	63	88	0.424	Final Order adopted August 29, 1967. Corrective program underway
Lakeview	Tamarack Creek	Secondary L	1,130	- - - - - - - - - - No Data Available - - - - - - - - - - - -						0.113	
Lansing	Grand River	Secondary AS	122,000	159	9	90	341	27	87	22.2	
Leoni Township, Jackson County	Grand River	None	5,000	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.50	Conference held before WRC February 24, 1966. Corrective program underway
Leslie	Huntoon Creek	Primary	1,810	139	78	42	146	87	39	0.169	Final Order adopted July 25, 1951.
Lowell	Grand River	Primary ST	2,600	119	73	33	66	32	39	0.260	
Lyons	Grand River	None	700	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -							Conference held before WRC February 24, 1966. Corrective program underway
Mason	Grand River	Secondary AS	5,000	264	3	99	260	8	97	0.232	
Michigan Reformatory (Ionia)	Grand River	Primary	2,500	275	155	43	147	78	46	0.60	
Middleville	Grand River	Primary IT	1,200	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.120	
Nashville	Thorn-apple River	Primary	1,525	- - - - No Data Available - - - -			160	76	49	0.171	
Ottawa County (Grand Valley State College)	Grand River	Secondary L		- - - - - - - - - - - - - - - - No Data Available - - - - - - - - - - - - - -							
Ovid	Maple River	None	1,500	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.15	Final Order adopted July 28, 1967. Plant to be in operation by August 1, 1968.
Paris Township (Part) (City of Kentwood)	Plaster Creek	None	19,000	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -							Conference held before WRC February 24, 1966. Corrective program underway

Community	Receiving Waters	Treatment Provided	Population (1964 est.)	Discharge Characteristics 5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
21. GRAND CONTINUED											
Parma	McKay Brook and Sandstone Creek	None	800	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.08	Final Order adopted April 27, 1967. Enforcement proceedings in progress. **
Perry	Looking-glass River	None	1,400	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.14	Conference held before WRC February 24, 1966. Corrective program underway
Pewamo	Stony Creek	None	400	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -							Conference held before WRC February 24, 1966. Corrective program underway
Pine Rest Hospital (Cutlerville)	Buck Creek	Secondary AS	500	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.05	
Plainfield Township, Kent County	Grand River York & Mill Creeks & Lamberton Lake	None	12,000	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						1.20	Final Order adopted July 28, 1966. Corrective program underway *
Portland	Grand River	Primary	3,500	253	147	42	327	145	55	0.293	Health Dept. Agreement *
Rockford	Rogue River	Primary	2,075	173	71	59	228	59	74	0.486	Final Order adopted February 26, 1952.
Sand Lake	Black Creek	Secondary L	395	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.040	
St. Johns	Hayworth Creek	Secondary TF	5,900	144	13	91	155	30	80	0.65	
Saranac	Lake Creek	Primary ST	1,100	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.11	Conference held before WRC February 24, 1966. Corrective program underway
Sparta	Nash Creek	Secondary TF	3,000	260	34	87	343	47	86	0.274	Final order adopted February 26, 1952 *
Spring Lake	Grand River	Primary IT	2,060	164	114	30	186	84	53	0.29	
Stanton	Fish Creek	Secondary L	1,200	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.12	Conference held before WRC February 24, 1966. Treatment provided.
State Prison of Southern Michigan (Jackson)	Grand River	Secondary TF	6,500	172	31	83	147	47	68	0.90	Additional treatment facilities, including phosphate removal, underway.
Vermontville	Thorn-apple River	None	800	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.08	Final Order adopted September 27, 1967. Corrective program underway
Walker	Tallman Creek	None	8,270	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.827	Conference held before WRC February 24, 1966. Corrective program underway
Webberville	Red Cedar	None	700	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.07	Final Order adopted January 17, 1968. Plant to be in operation by June 1, 1969.
Williamston	Grand River	Primary	2,215	194	145	25	250	90	[illegible]	[illegible]	Final Order adopted July 25, 1951. Additional facilities underway.
Woodland	McArthur Drain and Woodland Drain	Primary IT	375	208	19	89	285	9	96	0.027	Final Order adopted January 28, 1959. *
Wyoming	Grand River	Secondary TF	52,000	100	19	81	155	33	76	7.25	Final Order adopted August 25, 1949 *

Community	Receiving Waters	Treatment Provided	Population (1964 est.)	Discharge Characteristics 5-day BOD Influent mg/1	5-day BOD Effluent mg/1	5-day BOD Effluent % Removal	Suspended Solids Influent mg/1	Suspended Solids Effluent mg/1	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
22. BLACK (HOLLAND)											
Bloomingdale	Black River	None	500	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -							Conference held before WRC August 24, 1966. Corrective program underway
Holland	Lake Macatawa	Primary	24,800	132	82	38	122	63	48	2.71	
Holland Township, Ottawa County	Black River	None		- - - - - - - - - - - - - - - No Data Available - - - - - - - - - - - - - - -							Conference held before WRC August 24, 1966. Corrective program underway
Jamestown Township	Black River	None	50	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.05	Conference held before WRC August 24, 1966. Corrective program underway
Zeeland	Black River	Secondary AS	3,900	191	9	95	251	23	89	0.388	
Zeeland Township, Ottawa County	Black River	None		- - - - - - - - - - - - - - - No Data Available - - - - - - - - - - - - - - -							Conference held before WRC August 24, 1966. Corrective program underway
23. KALAMAZOO											
Albion	Kalamazoo River	Primary	12,800	117	77	32	124	67	42	2.22	
Allegan	Kalamazoo River	Primary IT	5,000	198	149	24	212	107	42	0.38	
Battle Creek	Kalamazoo River	Secondary TF	40,700	385	98	75	468	58	87	10.7	Order adopted April 28, 1954 *
Bellevue	Battle Creek River	None	1,300	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.130	Final order adopted December 15, 1966. **
Charlotte	Battle Creek River	Secondary TF	8,100	298	43	86	207	116	44	0.55	Order of Determination adopted September 26, 1950.
Concord	Kalamazoo River	None	1,000	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.10	Conference held before WRC August 24, 1966. Corrective program underway
Douglas	Kalamazoo River	Septic tanks tile fields	600	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.06	Conference held before WRC August 24, 1966. Correction by individual on-site systems.
Fennville	Mann Creek	Secondary L	705	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.071	
Galesburg	Kalamazoo River	None	1,410	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.14	Conference held before WRC August 24, 1966. Corrective program underway
Hopkins	Rabbit River	None	550	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.055	Conference held before WRC October 28, 1966. Corrective program underway
Kalamazoo	Kalamazoo River	Secondary AS	84,200	200	18.5	89	---	82	---	24.5	Final order adopted December 19, 1950.
Marshall	Kalamazoo River	Primary	6,700	74	62	16	106	43	57	2.14	Final order adopted September 27, 1949.
Olivet	Indian Creek	Secondary L	1,185	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.119	Final Order adopted February 18, 1965.

Community	Receiving Waters	Treatment Provided	Population (1964 est.)	5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
3. KALAMAZOO CONTINUED											
Otsego	Kalamazoo River	Secondary TF	4,300	407	183	55	316	88	72	0.46	Final Order adopted October 24, 1951.
Parchment	Kalamazoo River	Secondary TF	1,565	149	27	82	168	27	84	0.319	Final Order adopted October 24, 1951.
Plainwell	Kalamazoo River	Secondary TF	3,400	224	53	76	255	74	71	0.314	Final Order adopted October 24, 1951.
Portage (Part)	Kalamazoo River	Secondary AS	1,400	252	25	90	234	16	93	0.14	
Saugatuck	Kalamazoo River	Primary	925	207	177	14	244	122	50	0.44	Final Order adopted July 26, 1950.
Spring Arbor	Kalamazoo River	Secondary L	700	- - - - - - - - - - - -	- No Data Available -	- - - - - - - - - - - -				[illegible]	
Springfield	Kalamazoo River	Secondary TF	4,600	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -					Final Order adopted March 25, 1959. Treatment provided by City of Battle Creek
Springport	Rice Creek	None	590	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.07	Conference held before WRC August 24, 1966. Corrective program underway
24. BLACK (SOUTH HAVEN)											
Bangor	Black River and Maple Creek	Secondary L	2,110	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.211	Final Order adopted October 25, 1962.
Bloomingdale	Black River	None	465	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.046	Conference held before WRC August 24, 1966. Corrective program underway
South Haven	Black River	Secondary AS	6,400	251	12	95	201	11	[illegible]	1.28	
25. PAW PAW											
Benton Township (Part)	Paw Paw River	Secondary AS	26,000	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -					Final Order adopted September 27, 1949. Treatment provided by City of Benton Harbor
Coloma	Paw Paw River	Primary	1,470	228	141	38	153	91	40	0.25	Final Order adopted February 21, 1956.
Hartford	Paw Paw River	Primary	2,305	149	97	35	325	190	40	0.13	
Lawrence	Paw Paw River	Primary	770	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.077	
Lawton	Paw Paw River	Secondary L	1,400	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.140	
Paw Paw	Paw Paw River	Primary	3,100	289	236	16	334	119	63	0.579	
Watervliet	Paw Paw River	Primary	1,820	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				[illegible]	

Community	Receiving Waters	Treatment Provided	Population (1966 est.)	Discharge Characteristics 5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
26. ST. JOSEPH (MICH.)											
Andrews University	St. Joseph River	Primary	7,000	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.20	Plans for secondary treatment have been approved.
Benton Harbor and St. Joseph	St. Joseph River	Secondary AS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22	89	5.51	Final Order adopted September 27, 1969.
Berrien Springs	St. Joseph River	Primary	1,950	[illegible]	76	[illegible]	[illegible]	[illegible]	[illegible]	0.16	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Branch County Medical Facilities		Primary	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -								Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Bronson	Sway Creek	Secondary TF	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.60	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Buchanan	St. Joseph River	Primary	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	56	0.78	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Cassopolis	Ground Waters	Secondary L & SI	2,030	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						[illegible]	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Centreville	Prairie River	None	[illegible]	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.100	Conference held before WRC August 24, 1966. Corrective program underway
Coldwater	Coldwater River	Secondary TF	9,700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	85	[illegible]	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Coldwater State Home and Training School	Mudd Creek	Secondary AS		[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968
Constantine	St. Joseph River	Primary	1,710	475	195	[illegible]	[illegible]	121	56	0.15	Final Order adopted February 18, 1965. Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Dowagiac	Dowagiac Creek	Primary	7,600	137	100	26	159	63	60	1.25	Order of Determination adopted September 26, 1957. Staff recommendation on adequacy of present treat- to be presented to WRC by March 1, 1968.
Eau Claire	Farmers Creek	None	565	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -						0.056	Final Order adopted June 24, 1965. Corrective program underway.
Glen Oaks Community College	Prairie River	None	- - - - - - - - - - - - No Data Available - - - - - - - - - - - -								Order of Determination adopted April 28, 1966.
Hillsdale	St. Joseph River	Secondary TF	7,000	160	30	75	212	[illegible]			[illegible] Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.

				Discharge Characteristics							
Community	Receiving Waters	Treatment Provided	Population (1964 est.)	5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
26. ST. JOSEPH CONTINUED											
Jonesville	St. Joseph River	None	1,900	No Data Available						0.190	Final Order adopted January 17, 1968.
Litchfield	St. Joseph River	None	1,000	No Data Available						0.100	Final Order adopted January 17, 1968.
Niles	St. Joseph River	Primary	15,800	93	47	49	177	69	61	2.89	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968. *
Quincy	Marble Lake	Primary	1,600	150	77	46	539	76	88	0.10	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Reading	Unnamed Drains	None	1,130	No Data Available						0.113	Final Order adopted July 27, 1967. Corrective program underway.
Stevensville	Hickory Creek	None	700	No Data Available						0.070	Final Order adopted May 26, 1967. Facilities to be in operation by June 1, 1972.
Sturgis	White Pigeon River	Secondary TF	9,500	264	39	85	388	62	84	1.05	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Three Rivers	St. Joseph River	Primary	7,400	105	59	44	136	60	55	1.29	Final Order adopted October 30, 1959. Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Union City	St. Joseph River	Secondary L	1,670	No Data Available						0.167	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Vicksburg	Portage Creek	Secondary TF	2,220	125	75	60	212	91	43	0.20	Order of Determination adopted January 23, 1951. Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968. *
MISCELLANEOUS DRAINAGE AREAS											
Bridgman	Tanner Creek	Secondary L	1,450	No Data Available						0.145	Final Order adopted September 24, 1959 *
Chikaming Township (Sawyer, Lakeside, Union Pier)	Galien River	None	3,480	No Data Available						0.348	Conference held before WRC August 25, 1966. Corrective program underway
Escanaba	Portage Creek	Secondary AS & TF	15,000	214	28	88	190	30	86	1.35	
Galien	Galien River	None	750	No Data Available						0.075	Conference held before WRC August 25, 1966. Corrective program underway
Harbor Pointe	Lake Michigan	Primary ST	800	No Data Available						[illegible]	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Harbor Springs	Lake Michigan	Primary FS	1,430	No Data Available						0.143	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.

				Discharge Characteristics							
Community	Receiving Waters	Treatment Provided	Population (1964 est.)	5-day BOD Influent mg/l	5-day BOD Effluent mg/l	5-day BOD Effluent % Removal	Suspended Solids Influent mg/l	Suspended Solids Effluent mg/l	Suspended Solids Effluent % Removal	Flow MGD	Status and Abatement Action
MISCELLANEOUS DRAINAGE AREAS CONTINUED											
Lake Township	Painterville Drain	None	2,020	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.202	Conference held before WRC August 25, 1966. Corrective program underway
New Buffalo	Galien River	Secondary AS	2,130	230	92	60	247	231	16	3.03	Final Order adopted October 19, 1942 *
Onekama	Portage Lake	None	470	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.047	Conference held before WRC December 16, 1966. Corrective program underway
Petoskey	Lake Michigan	Primary CP	6,400	241	174	29	309	77	76	0.843	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Suttons Bay	Lake Michigan	Secondary L	420	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.042	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.
Three Oaks	Deer and Spring Creeks	None	1,800	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.18	Final Order adopted February 23, 1967. **
Wequetonsing	Lake Michigan	Primary IT	1,000	- - - - - - - - - - - -	No Data Available	- - - - - - - - - - - -				0.100	Staff recommendation on adequacy of present treatment to be presented to WRC by March 1, 1968.

Abbreviations

FS	Fine Screen
CP	Chemical Precipitation
ST	Septic Tank
IT	Imhoff Tank
AS	Activated Sludge
TF	Trickling Filter
L	Lagoons
SF	Sand Filter
SI	Spray Irrigation

APPENDIX J

POSSIBLE EFFECTS OF THE ALEWIFE DIE-OFF ON LAKE MICHIGAN WATER QUALITY

Possible Effects of the Alewife Die-off on Lake Michigan Water Quality

August-September 1967

Observations of past years on the condition of the Lake Michigan shoreline waters by the Michigan Water Resources Commission indicated a depression of water quality and general nuisance conditions during periods of alewife die-offs. The 1967 die-off was exceptionally heavy in June and July and created massive accumulations of dead and dying alewives along Michigan's Lake Michigan beaches. The value of our beach water sampling program for bacteriological analysis was questionable. Coliform bacteria far exceeded the levels approved for safe swimming with several instances of concentrations in excess of 500,000/100 ml. A small scale laboratory study was made during August and September to investigate the water quality degradation potential of decomposing alewives. Our experiment was not intended to be a definitive study of the problem. Our data cannot be accurately expanded to apply to Lake Michigan due to the crudeness of the experimental design. However, our results lead to conjecture on the significance of alewife die-offs to shoreline water quality conditions in Lake Michigan.

METHODS

Field studies were made to sample the surface waters of Lake Michigan for various water quality parameters during the period of alewife die-off. Sample locations were along a transect line from the beachwash out into the lake for 2,000 yards. The principal parameters measured were coliform bacteria concentrations, dissolved oxygen, and biochemical oxygen demand. Two thousand yards offshore 25 gallons of Lake Michigan water were collected in clean 5-gallon glass containers for use in laboratory studies. Dying alewives were collected and iced for use in these laboratory studies.

Laboratory experiments were designed to evaluate the extent of water quality degradation created by the decomposition of alewives. Six plastic tubs of approximately 8-gallon capacity were used as the experimental containers. These were divided into 2 series of 3 tubs each. Series 1 tubs were filled with approximately 7 1/2 gallons of Lansing tap water. Series 2 tubs were filled with approximately 7 1/2 gallons of Lake Michigan water. Two tubs, 1 from each series, were controls and no fish were introduced into them (Tubs 1A, 2A). One whole, freshly-dead 6-inch alewife was placed into the second tub of each series (Tubs 1B, 2B). The remaining tub of each series received a freshly-dead 6-inch alewife that had been cut into 6 pieces (Tubs 1C, 2C). These chopped fish were to simulate those broken up by wave and abrasive action in the beach waters. All 6 tubs were placed on the roof of the Michigan Water Resources Commission building in downtown Lansing and covered with a double layer of cheesecloth to guard against excessive contamination.

As the fish underwent decomposition various parameters were measured. Dissolved oxygen, biochemical oxygen demand, pH, nitrate nitrogen. ammonia nitrogen, soluble orthophosphate, and total phosphate determinations as well as coliform and fecal coliform counts/100 ml of water were made on all tubs before the introduction of fish and at irregular intervals throughout the 23 days of the study. Samples were always taken in the afternoon.

On the 9th day of the study the presence of algae was obvious. Grab samples were taken for algae counts at that time and on the remaining sample dates. These samples were counted by using a Sedgewick-Rafter counting chamber and the populations presented as number of cells/ml.

Sampling was conducted in the following manner: 1) Samples for dissolved oxygen analyses were taken from all 6 tubs; 2) The 2 tubs containing chopped fish [1C, 2C] were vigorously agitated to simulate wave action; 3) The remaining tubs were gently stirred; 4) Water samples were taken from all tubs for the other chemical and algal analyses.

FIELD STUDIES

On August 3, 1967 an attempt was made to collect water samples of Lake Michigan at Ludington, Michigan. Due to gale conditions on the lake, samples were limited to those taken from the lake side of the south breakwater at Ludington. Coliform bacteria counts ranged between 13,000 and 24,000/100 ml; fecal coliforms were between 10 and 50/100 ml; dissolved oxygen was lower than would be expected, 7.2 to 7.8 mg/l, although still above 85% saturation; and BOD was higher than would be expected, 8.8 to 15.0 mg/l. Temperature was 24-25°C. The alewife die-off was well past its peak at this time and location, with only scattered masses of several hundred fish floating around the breakwater.

On August 15, 1967 another effort was made to collect field data on Lake Michigan. It was necessary to go north to Frankfort, Michigan since virtually no dead alewives were encountered to the south. Even the waters off Frankfort contained very few dead alewives. Apparently the shoreline waters from Ludington to Frankfort had been recently "cleansed" by a new water mass created by upwelling. Water temperatures taken by the Water Resources Commission Beach Survey on August 15, 1967 at Frankfort averaged 15°F lower than those taken on August 1, 1967.

Quantities of broken and decomposed alewives were present in the beachwash and in decreasing numbers out into the lake. At 2,000 yards from shore it was almost impossible to find a dead alewife. In collecting fish for the laboratory study only 4 fish were found in a dying condition and 2 were considered as freshly dead. All other fish observed were too decomposed for use in the study.

Water quality was poorest in the beach waters containing accumulated alewives and improved with increased distance from the shore (Table 1). Dissolved oxygen ranged from a low of 9.2 mg/l inshore to 11.2 mg/l 2,000 yards offshore. This was magnified by a 16°F difference in temperature and accompanying changes in oxygen saturation levels. The BOD's were slightly higher (6.0 mg/l) in the beachwash area than one would normally expect to find when alewives are absent. The highest coliform counts were found inshore. Their diminution offshore correlates well with diminution of BOD. During periods of maximum alewife accumulation the BOD must be exceptionally high with accompanying effect on dissolved oxygen concentration.

LABORATORY STUDIES

Bacteriological Aspects

Extremely high coliform and high fecal coliform populations developed in the 4 study tubs containing fish, while both control tubs maintained very low populations (Table 2, Figure 1). Following a near logarithmic increase, peak populations of coliforms were attained 5 to 9 days after the introduction of fish. These population maxima ranged from 360,000 to 1,500,000/100 ml before diminishing to approximately 1,000/100 ml in all tubs with fish. Fecal coliform populations peaked at maximum counts ranging from 1,000 to 3,500/100 ml.

These data suggest that high coliform counts recorded from Lake Michigan beaches during the 1966-1967 periods of alewife die-off are most probably due to the accumulated dead fish. These high counts partially negated the value of beach bacteria sampling as an indication of sewage contamination. Fecal coliforms are now included with coliforms as a standard test on beach surveys to enable differentiation between contamination from alewives and sewage. The high fecal coliform populations measured in the study tubs should be investigated further to determine if they arose naturally or from contamination. If they occurred naturally the detection of human sanitary wastes along Lake Michigan beaches during alewife die-offs will be impaired.

Dissolved Oxygen and Biochemical Oxygen Demand

Extreme changes in DO and BOD were apparent in the experimental tubs (Figure 2 and Table 3). By the end of the second day DO in 3 of the 4 tubs with alewives was 0 and <1.0 mg/l in the 4th. DO returned between the 9th and 12th days with the development of algae blooms. DO rose to a measured high of 29 mg/l on the 12th day, but in all probability oxygen was 0 at night. BOD increased from 2 mg/l in test tubs with alewives to concentrations between 45 and 104 mg/l.

pH

Because of its relationship with algal populations, DO, and carbon dioxide, the pH in the test tubs most probably underwent more extreme variation than our data show (Figure 2 and Table 3). It would not be unusual to record diurnal variations of well over a unit in a natural algae bloom condition. It is doubtful if our pH data could be meaningfully interpreted.

Nutrient Release

It was planned to measure several forms of algal nutrients during the experiments. However, the added analytical load came during our busiest season and we compromised on ammonia nitrogen, soluble orthophosphate, and total phosphate.

Ammonia nitrogen increased to between 9.6 and 14.0 mg/l in the experimental tubs. Peak concentrations were measured on the 9th day, after which the ammonia level decreased (Table 3 and Figure 3).

Phosphorus was released rapidly from the decaying fish (Table 3 and Figure 3). Each single dead alewife released more than 2.0 mg/l total phosphate within 2 days. This early release was virtually all as soluble orthophosphate, the form most readily taken up by algae. As algal blooms developed, the available soluble orthophosphate decreased to 0 in the Lake Michigan water tubs. Total phosphate remained relatively steady, suggesting it had been assimilated into the algae cells.

Soluble orthophosphate concentrations peaked as early as the second day and as late as the ninth day. Maximum concentration was 6.3 mg/l. Total phosphate released from the individual fish ranged between 113 and 201 mg PO_4 based on average tub water volume of 6.8 gallons.

Algae

As the nutrients became available they were utilized by algae which quickly built up dense blooms of small, single celled green algae (Table 4). A dominant form was *Chlorococcum*, characteristically associated with dead fish. Other genera prominant in the algal flora were *Scenedesmus*, *Euglena*, and *Chlamydomonas*. Lesser numbers of several additional genera were also present.

The algal populations of the tubs containing fish exploded from less than 100 cells/ml to maximum populations ranging from 565,800 to 3,187,800 cells/ml. Relationship of this build up with bacteria populations and nutrient concentrations are graphed in Figures 4 and 5. The tap water control tub was apparently contaminated, for the algal population increased from 35 cells/ml of unknown genera to 11,765 cells/ml, predominately *Chlorococcum* and *Scenedesmus*. Algal cell counts in the lake water control remained low, attaining a maximum population of only 759 cells/ml with diatoms predominating.

DISCUSSION

One agency has estimated that a few hundred million pounds of alewives died in Lake Michigan during 1967. For the purpose of this report we will use 300 million pounds. Analytical work by the U.S. Bureau of Commercial Fisheries on several groups of alewives has shown that alewives about 6-inches long contain approximately 2.23 grams of phosphorus per pound of fish. Thus, 300 million pounds of dead alewives could release 2,300 tons of phosphates into Lake Michigan. The concentration of soluble orthophosphate as PO_4 commonly claimed sufficient to create nuisance algae conditions in water is 0.03 mg/l. If two-thirds of the released phosphorus was in the form of soluble orthophosphate the potential exists from this source alone to bring approximately 11 cubic miles of phosphorus-free water to the point at which nuisance algae blooms could occur. The relationship between the amount of dead alewives, phosphates released, and water mass fertilized is portrayed in Figure 6.

It is generally acknowledged that during the summer the water mass along Michigan's west coast from Benton Harbor-St. Joseph to Little Point Sable moves northward and is discrete unless broken up by strong winds. The U.S. Bureau of Commercial Fisheries aerial survey during the die-off showed that most dead alewives were concentrated in the southern tip of Lake Michigan and in a band along both shores in the southern two-thirds of the lake. Windrows of dead alewives collect in the shallower water beach zone. Nutrients from the decomposing fish would be released into this discrete, surface water mass which is already enriched by tributary rivers draining urban and agricultural areas.

There are roughly 2,240,000 acre feet of water inside the 30-foot depth contour from the Indiana-Michigan state line to the Leelanau Peninsula tip. Assuming 2/3 of the phosphorus released during alewife decomposition is available for uptake then 18,700,000 pounds of decomposing alewives would be necessary to bring that amount of phosphorus-free water to the critical nuisance algae producing level. This stretch of shore comprises approximately 20% of the total Lake Michigan coastline. Twenty percent of the estimated alewife die-off of 300 million pounds is 60 million pounds. It seems highly probable that more than the 18,700,000 pounds needed to bring the nutrient concentration to nuisance-potential levels would accumulate in this area.

Growing alewives concentrate phosphorus which is already present in the lake. It is normal for phosphorus to be recycled upon their death, but because of their unusually high population and habit of dying during a short period of the year in the alongshore waters, the phosphorus is released in a relatively small volume of water. It is concluded that phosphate released from decomposing alewives in the alongshore water mass of Lake Michigan could be a significant factor in the production of algae. Nuisances which can develop with increases in algal populations include a reduction in transparency, reduction in length of filter runs at water plants, possible taste and odor problems in drinking water, interference with swimming, and deposition of filamentous algae on beaches.

SUMMARY

1. Routine monitoring of Michigan's swimming areas showed degradation of water quality in association with alewife die-offs in the summers of 1966 and 1967.
2. A simple experiment to trace various water quality parameters in open tubs containing single decomposing alewives was undertaken.
3. Significant changes in water quality in the experiments include:
    - a. Increase in coliform and fecal coliform bacteria counts.
    - b. Increase in BOD.
    - c. Decrease in DO to anaerobic conditions followed by increase which accompanied algae build up.
    - d. A great increase in algal cell numbers.
    - e. Rapid release of ammonia and phosphates.
4. Decomposition of masses of alewives in the alongshore waters of Lake Michigan could promote phenomena of unknown magnitude similar to those which occurred in the study tubs
5. Abnormally high coliform bacteria counts due to the presence of dead alewives partially negate the value of beach bacterial sampling as an indication of sewage contamination.

6. The discrete, alongshore water mass of Lake Michigan's southeastern shore is already enriched by tributary rivers draining urban and agricultural land. Additional nutrients from decomposing alewives could be a significant factor in the increased production of algae. Such growths could result in reduction in transparency, reduction in length of filter runs at water plants, possible taste and odor problems in drinking water, interference with swimming, and deposition of filamentous algae on beaches.

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Michigan Department of Conservation
January 27, 1968.

Table 1. Lake Michigan water quality off Frankfort south of the south breakwater, August 15, 1967.

Distance off shore	Temperature °C	Coliforms c/100 ml	BOD mg/l	Dissolved oxygen mg/l
Beach wash	18	Contaminated	6.0	9.2
10 feet	16.5	2,600	4.9	9.4
25 feet	17	2,800	3.7	9.6
50 feet	17	1,000	6.2	9.8
75 feet	16	800	2.2	9.8
100 feet	15	300	1.4	10.0
100 yards	15	<100	1.2	10.4
200 yards	15	<100	1.6	10.6
300 yards	15	<100	1.8	11.0
500 yards	14	<100	1.8	11.0
1000 yards	13	<100	1.8	11.0
2000 yards	9	<100	1.6	11.2

Distance off shore	Total solids mg/l	pH	SO PO_4 mg/l	T PO_4 mg/l	NO_3 mg/l	Hardness mg/l
250 yards	170	8.3	0.00	0.00	0.20	130
2000 yards	165	8.3	0.00	0.00	0.20	135

Table 2. Coliform and fecal coliform bacteria populations in experimental tubs, August-September 1967.

Time in days	Lansing tap water series						Lake Michigan water series					
	1A Control		1B Whole fish		1C Chopped fish		2A Control		2B Whole fish		2C Chopped fish	
	Coliform	Fecal	Coliform	Fecal	Coliform	Fecal	Coliform	Fecal	Coliform	Fecal	Coliform	Fecal
Start	<10	--	<10	--	<10	--	<10	--	<10	--	<10	--
1	<2	<100	4,000	200	6,000	1,000	<100	<100	25,000	2,200	7,000	400
2	<2	<2	17,000	3,500	20,000	700	<100	<10	60,000	2,100	20,000	200
5	<2	<2	110,000	3,000	220,000	200	<2	<2	500,000	2,100	750,000	300
7	<2	<2	360,000	1,000	100,000	1,000	<2	<2	350,000	3,000	1,500,000	1,000
9	<2	<2	150,000	500	430,000	500	<2	<2	190,000	1,100	220,000	<100
12	<2	<2	10,000	<100	20,000	<100	<2	<2	10,000	<100	<10,000	<100
23	<2	<2	2,000	<100	<1,000	<100	<2	<2	<1,000	<100	<1,000	<100

Figure 1. Coliform and fecal coliform bacteria populations in experimental tubs, August-September, 1967.

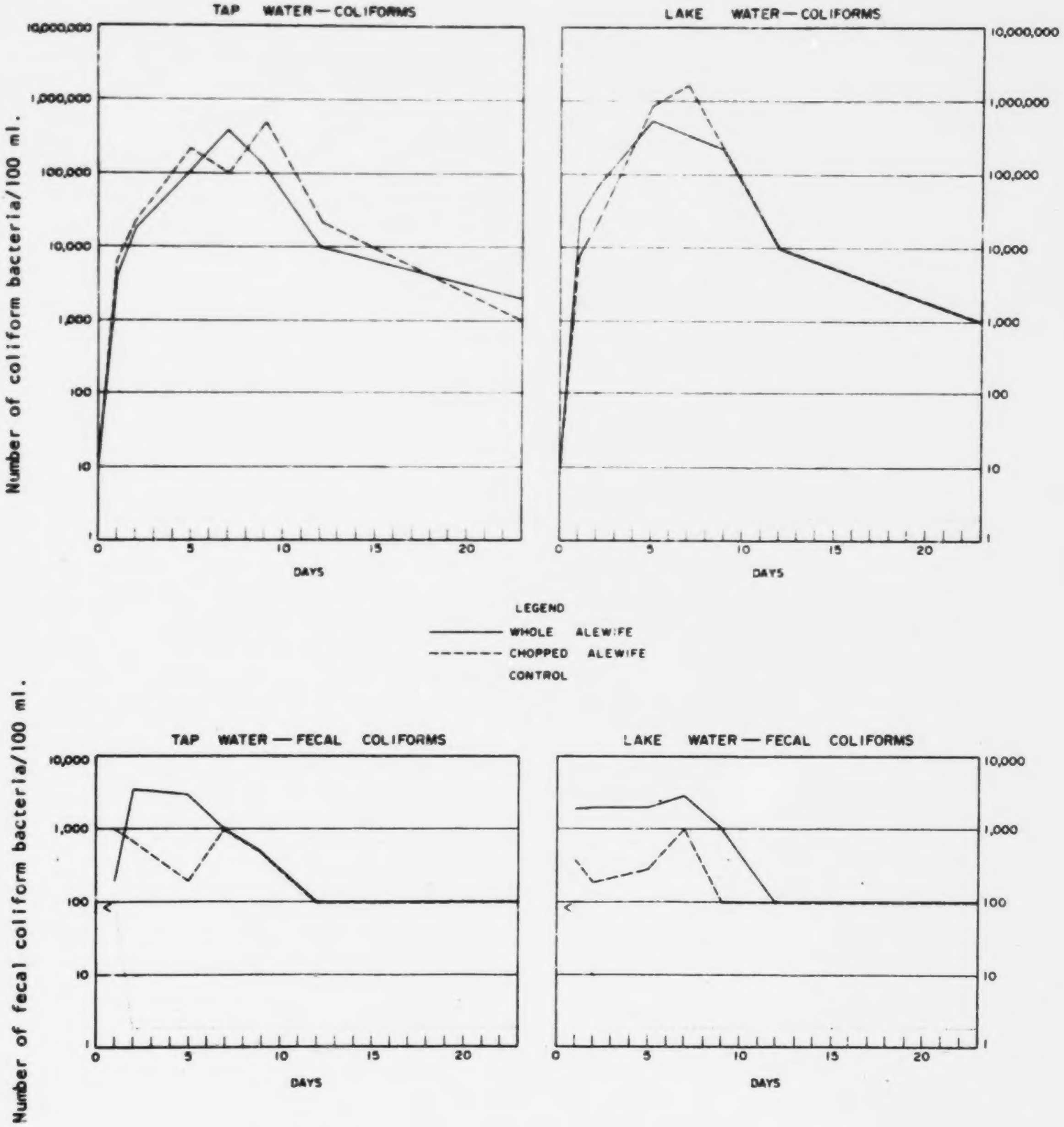


Table 3. Water quality in tubs during decomposition of alewives, August-September 1967. All concentrations in mg/l except pH.

Lansing tap water, series 1

Time in days	Control - 1A								Whole alewife - 1B								Chopped alewife - 1C							
	Temp. °C	DO	BOD	pH	NO_3-N	NH_3-N	SO PO_4	T PO_4	Temp. °C	DO	BOD	pH	NO_3-N	NH_3-N	SO PO_4	T PO_4	Temp. °C	DO	BOD	pH	NO_3-N	NH_3-N	SO PO_4	T PO_4
Start	--	5.8	0.6	9.4	0.00	--	0.05	0.40	--	5.8	0.6	9.4	0.00	--	0.05	0.40	--	5.8	0.6	9.4	0.00	--	0.05	0.40
1	29	7.0	0.4	9.1	--	--	0.05	0.25	29	6.3	>13.4	8.1	--	--	2.1	2.5	29	3.2	33	7.3	--	--	3.7	4.0
2	25	7.3	1.6	8.4	--	0.0	0.00	--	25	0.0	36	7.0	--	3.6	4.3	4.3	25	0.0	39	7.0	--	3.8	4.3	4.3
5	27	7.1	2.2	7.6	--	0.0	0.00	--	27	0.0	54	7.0	--	8.8	5.7	--	27	0.0	60	6.9	--	8.0	5.0	--
7	26	6.7	2.3	7.5	--	0.0	0.05	--	26	0.0	64	7.1	--	13.0	6.1	--	26	0.0	90	7.0	--	10.0	5.3	--
9	31	6.8	2.0	7.5	--	0.0	0.00	0.30	31	0.0	100	7.2	--	14.0	6.3	8.1	31	0.0	68	7.1	--	13.0	6.0	8.4
12	28	8.0	--	7.3	0.00	0.0	0.1	0.25	28	3.2	--	7.2	0.00	11.0	5.5	6.2	28	20.0	--	8.2	0.00	7.4	4.5	5.8
23	--	8.0	1.6	7.3	0.00	--	0.00	0.25	--	8.0	38	7.7	0.00	--	0.30	8.0	--	10.0	104	8.0	0.00	--	0.10	20.0

Lake Michigan water, series 2

Time in days	Control 2A								Whole alewife - 2B								Chopped alewife - 2 C							
	Temp. °C	DO	BOD	pH	NO_3-N	NH_3-N	SO PO_4	T PO_4	Temp. °C	DO	BOD	pH	NO_3-N	NH_3-N	SO PO_4	T PO_4	Temp. °C	DO	BOD	pH	NO_3-N	NH_3-N	SO PO_4	T PO_4
Start	--	8.0	1.6	8.3	0.15	--	0.00	0.10	--	8.0	1.6	8.3	0.15	--	0.00	0.10	--	8.0	1.6	8.3	0.15	--	0.00	0.10
1	29	7.7	3.5	8.4	--	--	0.00	0.00	29	1.0	11	7.6	--	--	2.1	2.8	29	1.5	11	7.6	--	--	1.6	1.9
2	25	7.2	2.2	8.2	--	0.0	0.00	--	25	0.0	28	7.3	--	3.7	3.7	3.7	25	0.9	17	7.3	--	3.2	2.1	2.1
5	27	7.1	1.5	8.2	--	0.0	0.00	--	27	0.0	45	7.4	--	8.6	4.5	--	27	0.0	32	7.4	--	7.4	1.9	--
7	26	7.3	1.5	8.2	--	0.0	0.00	--	26	0.0	44	7.5	--	10.0	4.7	--	26	0.0	44	7.4	--	9.6	1.8	--
9	31	7.0	1.0	8.1	--	0.0	0.00	0.05	31	4.0	42	7.7	--	12.0	4.0	7.1	31	18.0	46	7.9	--	9.6	0.2	4.7
12	28	8.0	--	8.0	0.00	0.1	0.00	0.10	28	29.0	--	9.6	0.00	3.2	0.75	4.4	28	28.4	--	10.0	0.00	0.2	0.50	2.5
23	--	9.0	2.0	7.8	0.00	--	0.00	0.15	--	10.5	16	7.9	0.00	--	0.00	4.5	--	16.6	20	7.7	0.00	--	0.00	2.5

Figure 2. Dissolved oxygen, biochemical oxygen demand, and pH concentrations in experimental tubs containing decomposing alewives, August-September 1967.

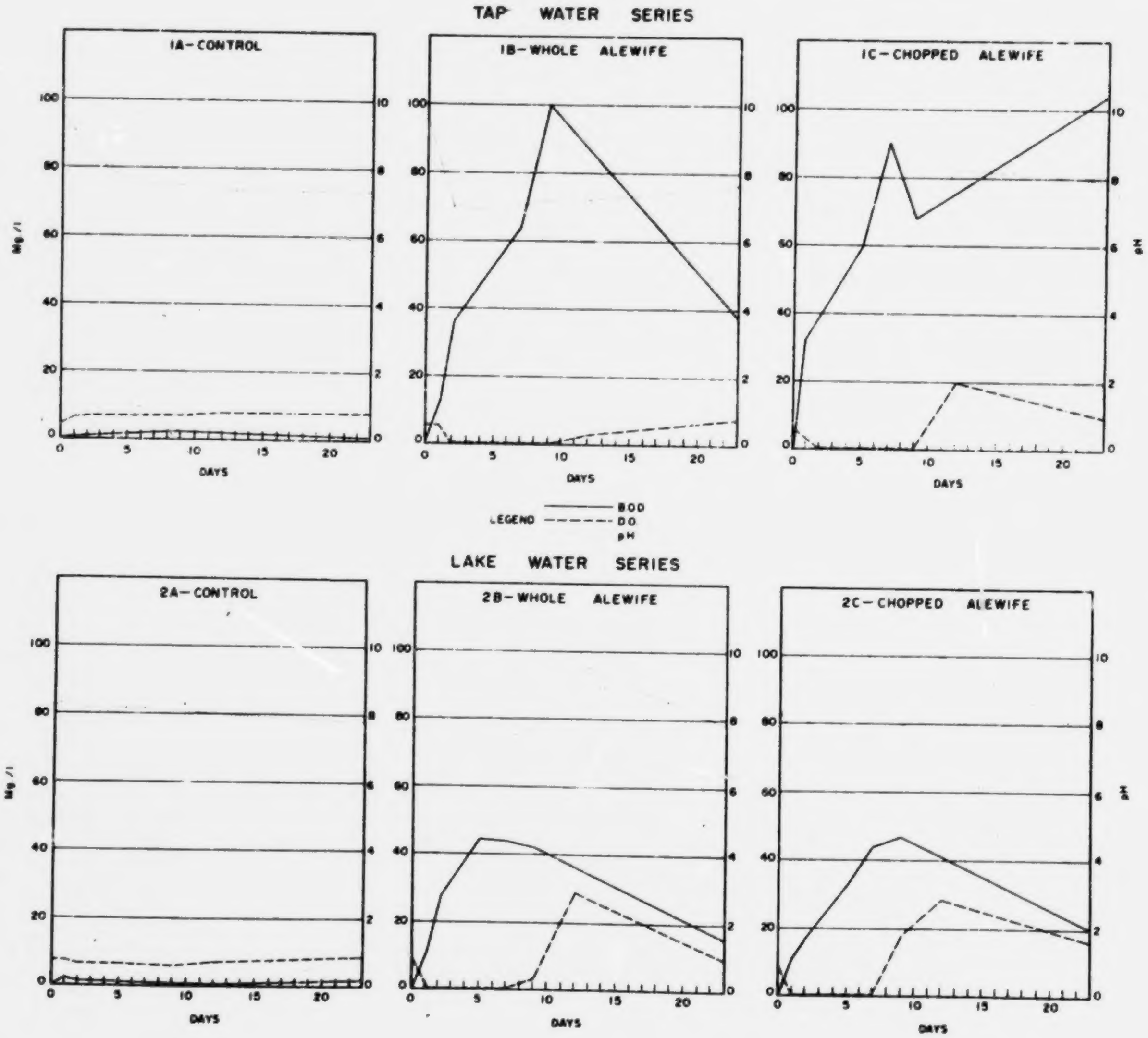


Figure 3. Ammonia, soluble orthophosphate, and total phosphate concentrations in experimental tubs containing decomposing alewives, August-September, 1967.

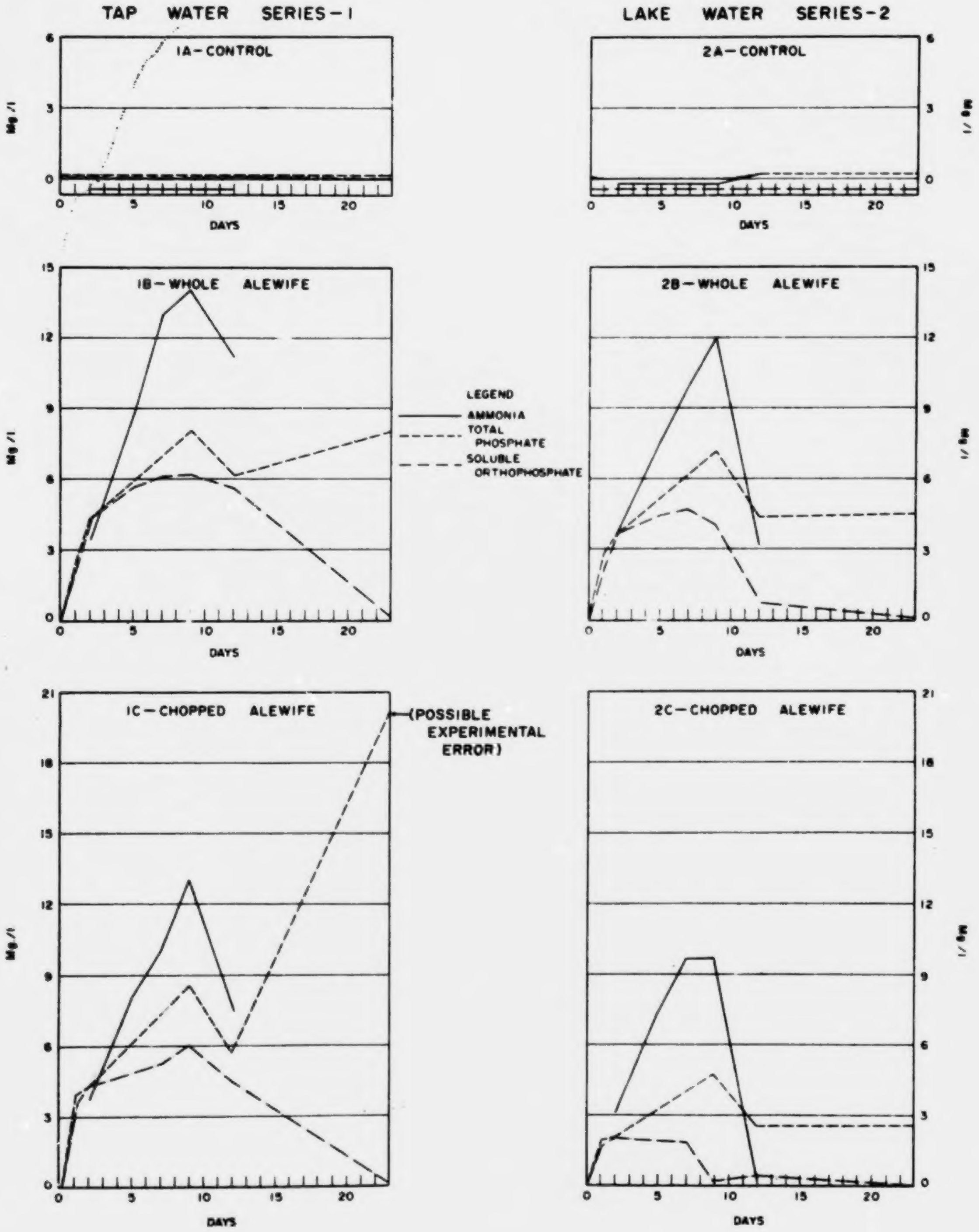


Table 4. Algae cell counts (Sedgewick-Rafter), experimental tubs, August-September 1967.

	Lansing tap water series			Lake Michigan water series		
Time in days	1A Control no fish	1B Whole fish	1C Chopped fish	2A Control no fish	2B Whole fish	2C Chopped fish
9	35	52	8,856	86	75,900	130,065
12	427	18,768	97,290	259	409,515	565,800
23	11,765	2,145,000	3,187,800	759	621,000	455,400

Figure 4. Relationship between coliform bacteria, total phosphate, soluble orthophosphate and plankton algae experimental control tubs with Lansing tap water and Lake Michigan water, August-September 1967.

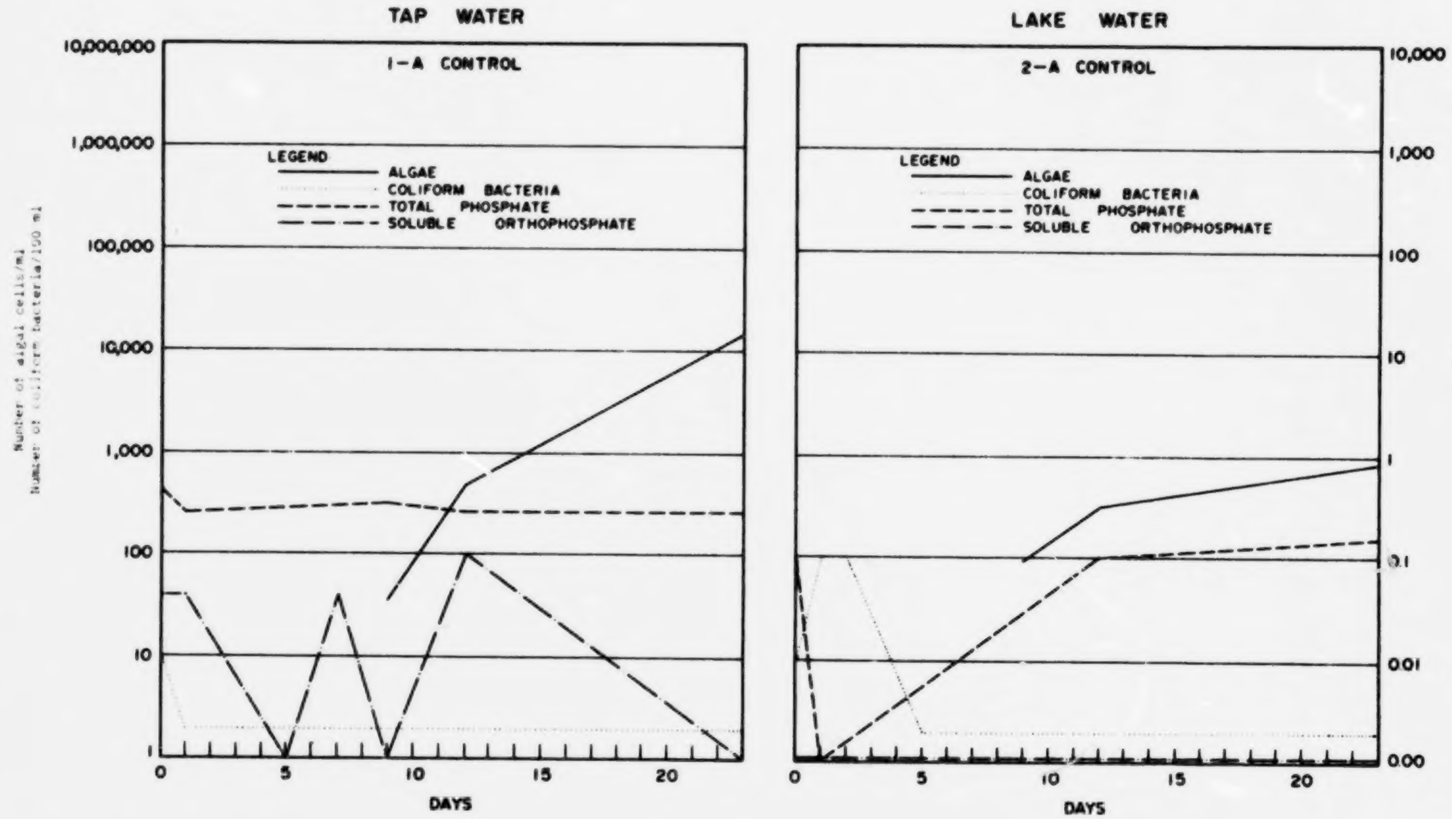
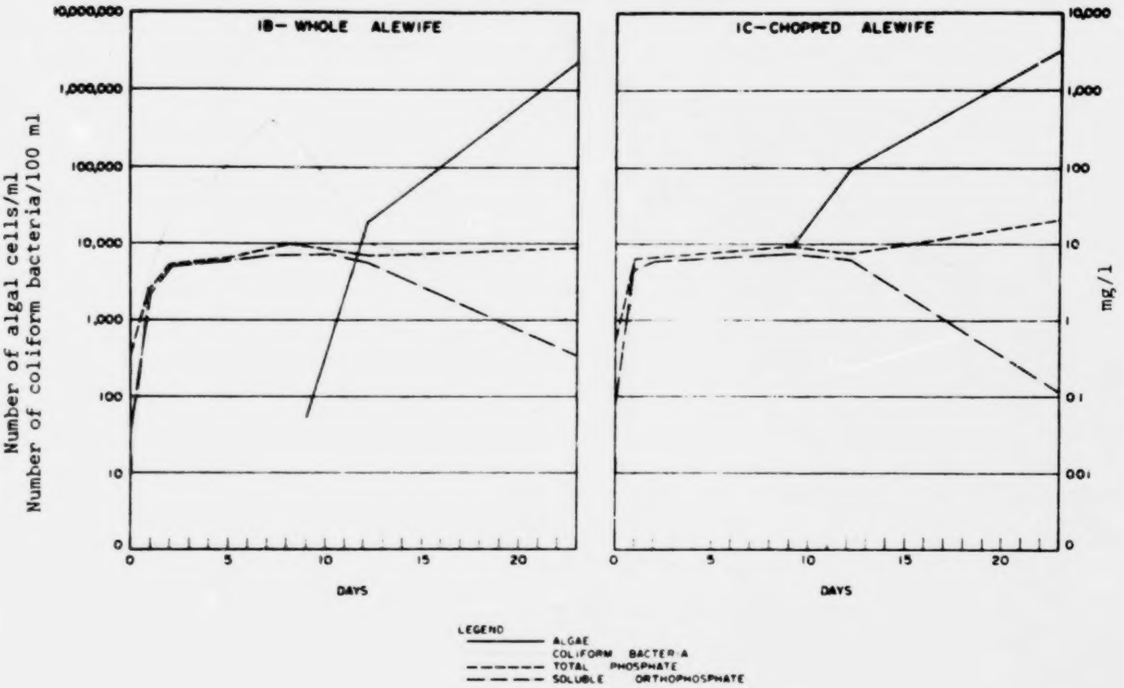


Figure 5. Relationship between coliform bacteria, total phosphate, soluble orthophosphate, and plankton algae, experimental test tubs with Lansing tap water and Lake Michigan water, August-September 1967.

TAP WATER SERIES



LAKE WATER SERIES

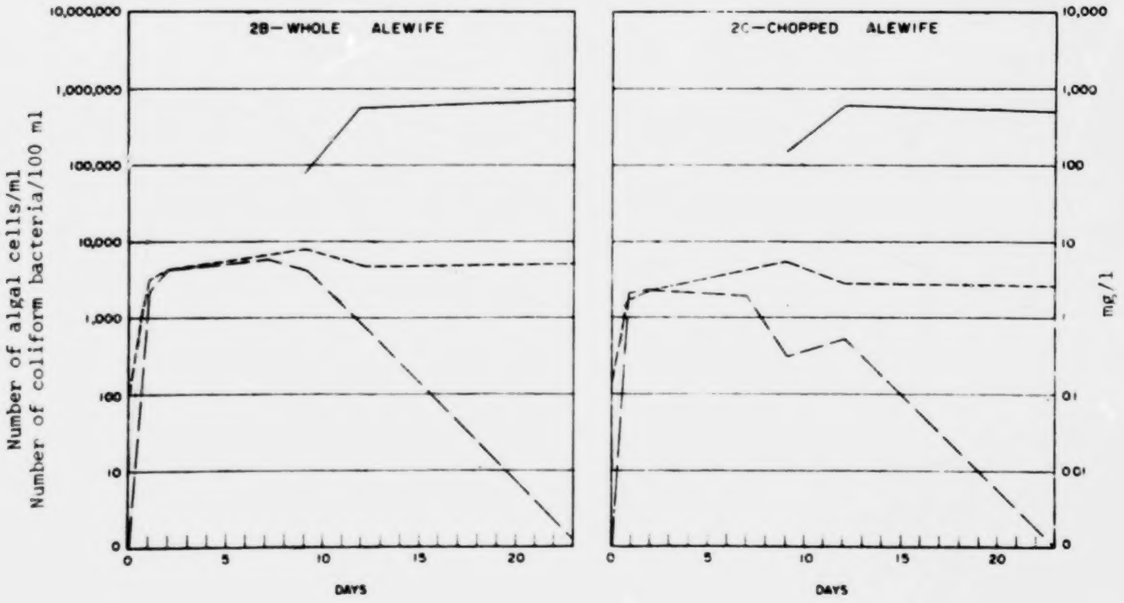
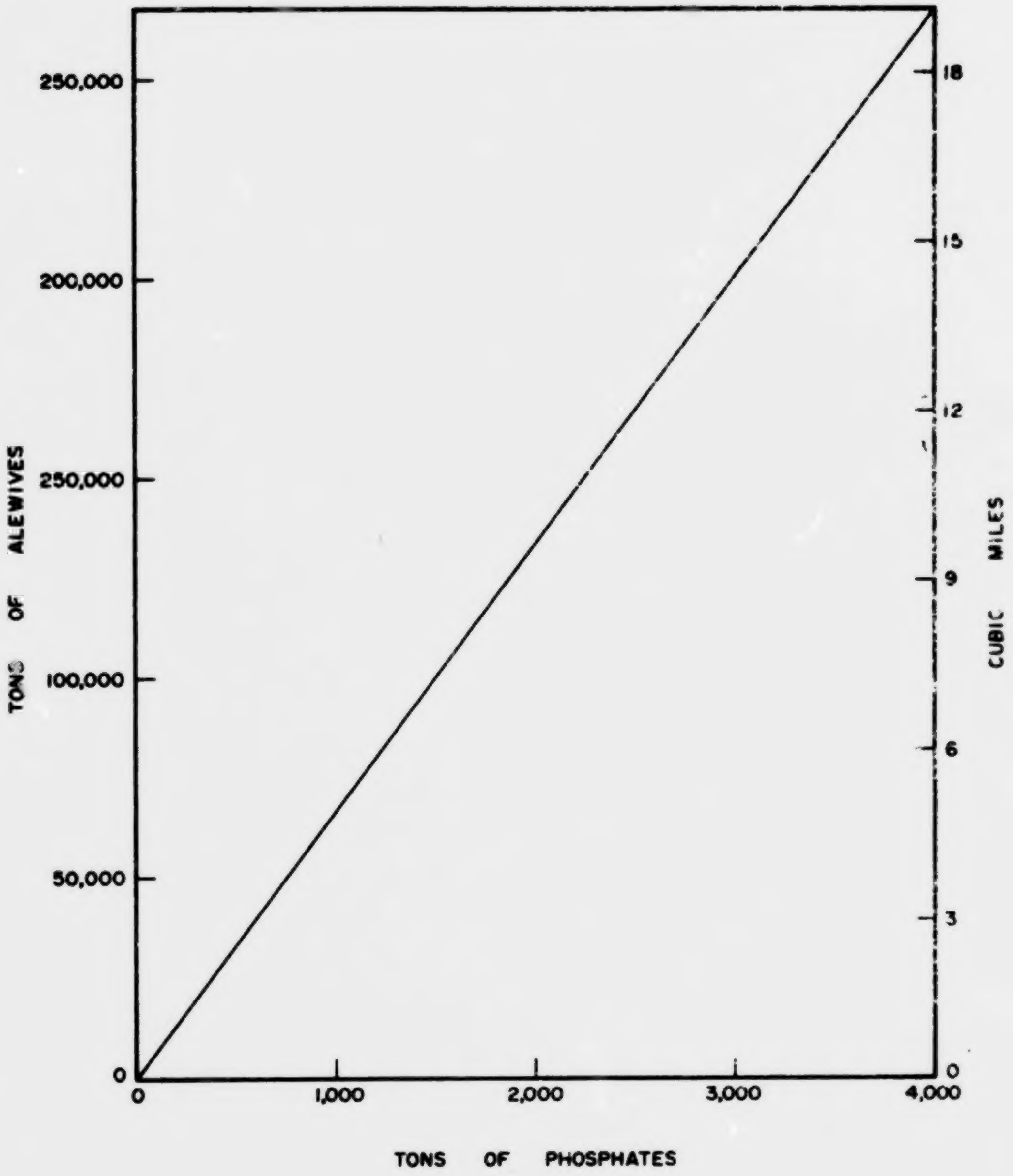


Figure 6. Relationships between potential total phosphate release as PO_4 from dead alewives and volume of phosphorus-free water which could be brought to 0.01 mg/l soluble orthophosphate (assuming 2/3 of the phosphate released was soluble orthophosphate).



APPENDIX K

PRELIMINARY SURVEY OF ALGAE PROBLEMS -
LAKE MICHIGAN BEACHES
AND
PHYTOPLANKTON SURVEY
MICHIGAN INSHORE WATERS OF SOUTH-CENTRAL
LAKE MICHIGAN

Preliminary Survey of Algae Problems, Lake Michigan Beaches,

August 4, 5, 1966.

A brief reconnaissance survey of Lake Michigan shoreline from South Haven north to Meinert's Park in Muskegon County was made on August 4 and 5, 1966 to learn if an algae problem was present in this area and, if so, to determine its extent. Complaints had been received prior to the survey stating that undesirable algae accumulations were occurring along some of these beaches. A minimum of 500 feet of shoreline was inspected at each of the 12 public beaches shown on Figure 1. Qualitative samples of plankton and algae were obtained from these beaches.

Filamentous algae (*Cladophora*) and alewives (*Alosa psuedoharengus*) were present in moderate amounts at the South Haven public beach. Several windrows of algae, fifteen feet in length and one foot wide, were observed on the bottom in shallow water near shore. Decaying alewives were mixed in this algal mass and one fresh-dead alewife was found per 25 feet of shoreline. The lifeguards stated that the algae and alewives had been a nuisance this year and the cause of numerous complaints. Proceeding north from South Haven, the next seven beaches had less of an algae and alewife problem, with the exception of the Allegan County Park where conditions were similar to those at South Haven.

At the Grand Haven State Park, Assistant Park Manager Marvin Gebbins said that algae accumulations and dead alewives had been a problem this year. The algae became so concentrated at times that he thought it would have been wise to close the beach to swimming. Bathers complained that their bathing suits had been stained by the algae. He observed that algae concentrations had varied with wind direction and intensity. There was not much of a problem at the time of my visit so I could not confirm his statements. *Cladophora* was observed in one-foot clumps on the bottom near shore. At Norton Park, 5½ miles to the north, an obvious algae problem existed. The waves washing on shore appeared green because of the intense concentration of suspended *Spirogyra*. The one-half mile of shoreline examined had a strip of thick algae extending 20 feet offshore. Decaying alewives were fairly abundant in this unsightly mass. The algae was so concentrated that a swimmer could not see his feet while standing in knee-deep water. The life guard said that this condition had been present in varying degrees of severity all summer.

Bronson Park, 4½ miles further north, had similar, but less pronounced conditions.

Lloyd Park, 12 miles north of Bronson Park, had clear water, no alewives, and only scattered clumps of algae.

Meinert County Park, 5 miles to the north of Lloyd Park, had conditions as bad as Norton Park. Mrs. Ramthum, who has operated the park for the last 13 years, said that this was the first time she had seen a problem of this type.

This survey substantiates the complaints received by the Water Resources Commission which stated that algae accumulations at some Lake Michigan beaches had reached nuisance proportions.

John G. Robinson
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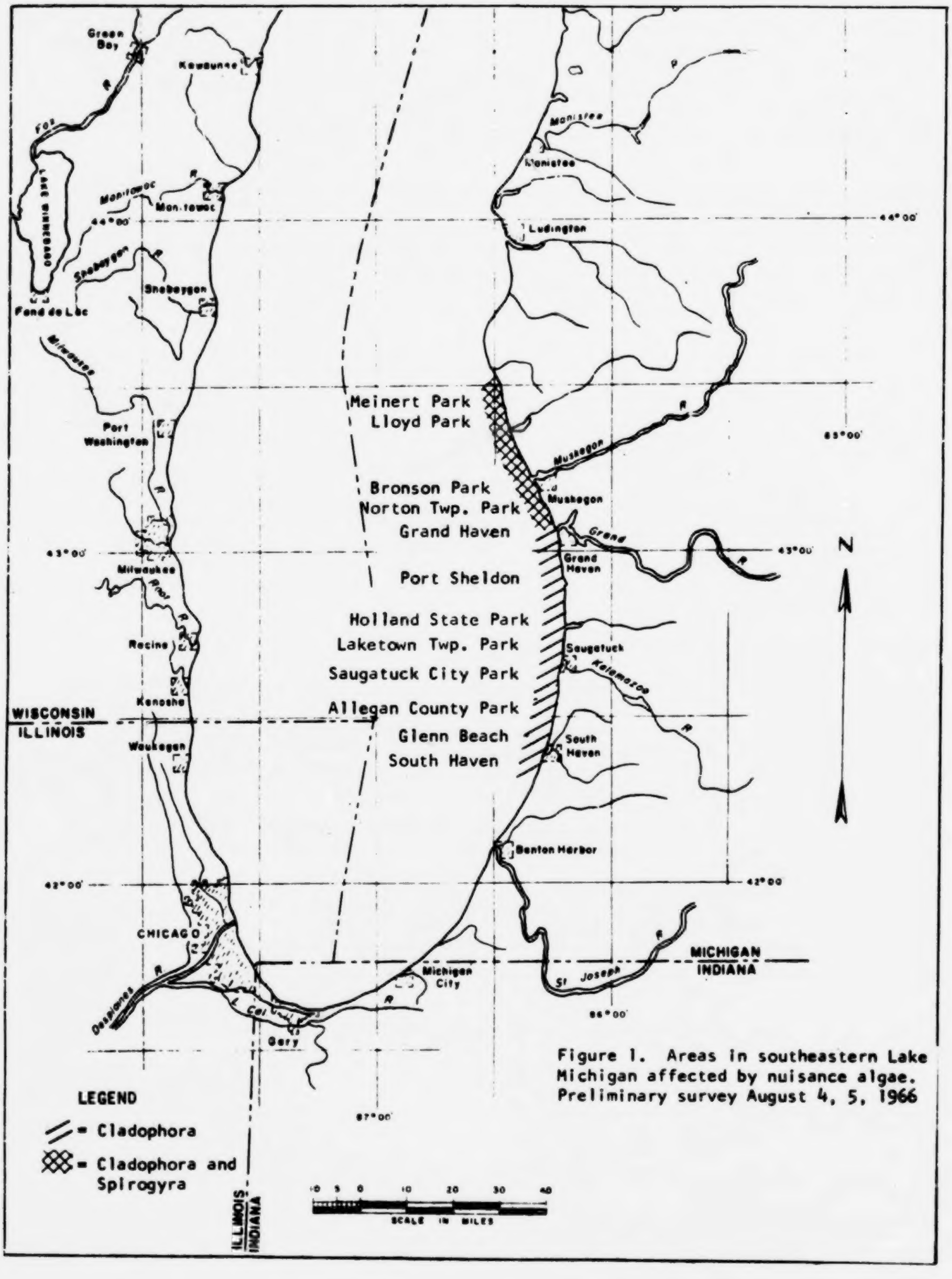
3/15/67

lmh


Green Bay
Kewaunee
Fox R
Lake Winnebago
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Bronson Park
Norton Twp. Park
Grand Haven
Port Sheldon
Holland State Park
Laketown Twp. Park
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N
LEGEND
// = Cladophora
▨ = Cladophora and Spirogyra
10 5 0 10 20 30 40
SCALE IN MILES
ILLINOIS
INDIANA

Figure 1. Areas in southeastern Lake Michigan affected by nuisance algae. Preliminary survey August 4, 5, 1966

PHYTOPLANKTON SURVEY

MICHIGAN INSHORE WATERS OF SOUTH CENTRAL

LAKE MICHIGAN

August 9-11, 1966

On August 4 and 5 a reconnaissance survey of several beaches along Lake Michigan showed that nuisance accumulations of algae were present around Muskegon and intermittently for 25 miles to the north. The purpose of this follow-up survey was to determine the offshore extent of these accumulations and to compare the plankton populations in the problem areas with those from other areas.

Between St. Joseph to the south and Manistee to the north, a shoreline distance of 163 miles, eight beaches were sampled (see Figure 1). Four lake samples were taken at each location, one each at the following distances offshore: 1 mile, 1/3 mile, 600 feet and 75 feet. A sample was also taken from tributary streams at seven of the locations.

Methods

Plankton was obtained by towing a plankton net with a 20" diameter opening and #25 silk bolting cloth two feet below the water's surface for 300 feet. The samples were preserved with formalin immediately after collection. Lake samples were taken upwind from the tributaries in order to avoid river plankton. The plankton was identified and counted in each sample by examination of 10 fields on two slides at 100 power. The count was made with a microscope using a 10X ocular and 10X objective. Identifications were made using 43X and 97X objectives. Each one-celled alga, filament and colony were counted as one organism. This method fails to take into account the size of the plankton. Therefore, estimates of dominance by volume were made by examining concentrated samples under low power. The term "total plankton count" refers to the summation of counts made at all four lake stations at each location.

St. Joseph and St. Joseph River

The total plankton count was higher here than at any other location (see Figure 2). The most abundant algae were: Anabaena 1 mile and 1/3 mile offshore; Melosira at 600 feet; and Fragilaria at 75 feet offshore. Volume comparisons (see Table 1) show that Melosira and Anabaena were the dominant phytoplankton offshore and that Fragilaria was predominant inshore. The comparatively high counts found at St. Joseph indicate enriched conditions. The predominant algae found here (with the exception of Fragilaria) are the type commonly found in eutrophic (rich in nutrients) situations.

The St. Joseph River (avg. discharge > 3,269 cfs) was greenish-brown in color because of the large standing crop of algae. Melosira made up 56% of this population numerically and 75% of its volume. Actinastrum, Scenedesmus, and Pediastrum were also very abundant. This river had the highest plankton count of the seven sampled.

South Haven and Black River

The total plankton count at this station was fourth highest of the seven sampled with Dinobryon numerically dominant and Melosira and Ceratium also abundant. The concentration of blue-green algae was seond only to that found in the St. Joseph area. Blue-greens are often abundant in enriched situations and are often associated with nuisance conditions. Gomphosphaeria and Anabaena (blue-greens) were found in every lake sample but not in the river. Ceratium, Fragilaria and Melosira dominated in volume.

The Black River (a relatively small river) had the second lowest plankton count of the stream samples. Numerically, Navicula constituted 84% of the phytoplankton.

Holland, Lake Macatawa, and Black River

This area had the third highest blue-green algae concentration due to the comparatively high numbers of Anabaena. Other features, however, such as low total counts dominated by typical oligotrophic (nutrient poor) types such as Fragilaria and Dinobryon indicate that nutrients were not abundant.

Lake Macatawa, which contributes a relatively small flow to Lake Michigan at Holland, was grass-green with a bloom (intense concentration) of the blue-green nuisance alga, *Aphanizomenon*. The total phytoplankton consisted of 85% blue-greens while the remainder was mainly *Pediastrum*.

Grand Haven and Grand River

The phytoplankton of this area was very similar to that found at Holland except that *Spirogyra*, a nuisance-type filamentous algae, was numerically and volumetrically dominant in the sample taken in the beach tow (75 feet offshore).

The Grand River (avg flow > 3,524 cfs) had a low phytoplankton count with the numerically dominant *Melosira* making up 27% of the total. *Actinastrum* and *Pediastrum* were the dominant non-flagellate greens. *Fragilaria* was also abundant. The blue-green *Aphanocapsa* and *Gomphosphaerium* represented 11% of the total potamoplankton (river plankton).

Muskegon, Muskegon Lake and River

Because of rough water only the samples from 1/3 mile and 75 feet offshore were collected. *Spirogyra* was dominant in number and volume in the inshore sample. This profusion of *Spirogyra* is evidence of highly enriched conditions. *Asterionella* and *Fragilaria* were dominant further offshore where very little *Spirogyra* was found.

Muskegon Lake was similar to Lake Macatawa in having a bloom of *Aphanizomenon*. *Anabaena*, *Anacystis* and *Gomphosphaerium* were also present, making the blue-greens equal to 84% of the total plankton. Average flow of the Muskegon River is > 1,877 cfs.

Benona (Stoney Lake)

All samples taken here except the beach tow had exceptionally low plankton concentrations (see Figure 2). The beach tow had by far the highest count of the four due to the numerically and volumetrically dominant *Spirogyra*. *Asterionella* and *Fragilaria* were dominant in the three samples taken further offshore. Only two filaments of *Spirogyra* were counted in the sample taken 300 feet offshore.

It is interesting to note that the offshore samples at this station contained the smallest amounts of plankton noted on the survey even though nuisance quantities of algae had accumulated near the shore.

Ludington, Pere Marquette Lake and River

This area had the second highest total phytoplankton count of the group due to *Melosira* which was also abundant in the Pere Marquette River. It made up 97% of the total potamoplankton. There were relatively few blue-green algae present in Lake Michigan and none in the river. *Fragilaria* and *Asterionella* were second and third in dominance in the lake samples. *Spirogyra* was not found in the offshore samples and only in very small quantities in the beach tow.

Visual observations of the beach area and shallows indicated good water quality.

Manistee, Manistee Lake and River

As was expected, this area had a low total phytoplankton count and a low count in the beach tow. The dominants were *Fragilaria* and *Asterionella*. *Anabaena*, *Tabellaria* and *Dinobryon* were present in low numbers at all stations.

The Manistee River had the lowest total count of the entire survey. All alga was sparse including the dominant pennate diatoms.

There was very little difference in the inshore and offshore phytoplankton counts at this station (see Figure 2 and 3). The low phytoplankton count in this area corresponded with the very clear, clean appearance of the swimming beach.

Observations and Summary

1. Combining the information gained from the reconnaissance survey of August 4, 5 and the follow-up survey of August 9-11, 1966 it is possible to roughly outline the areas which had algae problems (see Table 2). Approximately 32 miles of Lake Michigan shoreline had nuisance accumulations of Spirogyra and Cladophora in August of 1966. The problem was first observed 6.5 miles south of Muskegon at Norton Township Park and extended intermittently to Benona, 25 miles north of Muskegon. At some beaches in this area the accumulations were not sufficient to cause nuisance conditions.

Sixty miles of shoreline from South Haven to Pentwater (excluding the area described in the above paragraph) had noticeable accumulations of Cladophora but little or no Spirogyra. Since Cladophora lays on the bottom in windrows it was not as objectionable as was the Spirogyra in suspension. Personnel in charge of these beaches voiced only moderate complaints concerning the necessity to rake up the algae once a week or so. In the area where Spirogyra was a problem, park managers received complaints of green-stained bathing suits and conditions unfit for swimming.

2. Comparing the eight areas studied, the algae at Holland and Manistee could be described as being the least indicative of enrichment. That found at Benona, Muskegon and St. Joseph were the most indicative of enrichment.

3. There were striking differences in the quantity and quality in the inshore phytoplankton and that found beyond 600 feet. Benona is the best example of this where the offshore plankton population was lower (see Figure 2) than the other six areas, while the inshore count was the highest registered. The inshore plankton was dominated by eutrophic species (Spirogyra and Cladophora) while the offshore organisms were more typical of oligotrophic waters. This suggests that during the summer of 1966 the water masses inshore and offshore from 600 feet out remained sufficiently different for long enough periods to support radically different algal populations.

4. Melosira, a filamentous diatom, was the dominant algae found at St. Joseph and Ludington, except in the samples taken one mile offshore. These high Melosira populations apparently had their origin in the tributary streams where their numbers reached bloom concentrations (see Table 1).

5. Spirogyra, the algae causing the most serious nuisance conditions along the shoreline, could not be traced to the tributaries since it was not found in any of the river samples.

6. Soluble orthophosphate concentrations were determined for each station (see Table 3). Of 30 samples 18 showed none present (which due to sensitivity limitations must be interpreted as < 0.01 mg/l), 11 were 0.01 mg/l and one was 0.02 mg/l. These are low levels of orthophosphate. There was not a consistent pattern of greater concentrations inshore than offshore. Concentrations in the more southerly tributary rivers were much higher than in the lake, with values ranging between 0.16 mg/l in the Muskegon to 0.56 mg/l in the Black River at South Haven. The Pere Marquette and Manistee had low concentrations.

7. On the basis of this short-term survey there is an apparent relationship between the areas in which nuisance algae occur along the Michigan coastline of Lake Michigan and the proximity of sources of plant nutrients contributed via major tributaries.

8. Assuming weather and current patterns in the future similar to those experienced in 1966 and continued contributions of present water quality from tributary streams we may expect annual reoccurrences of nuisance algae conditions.

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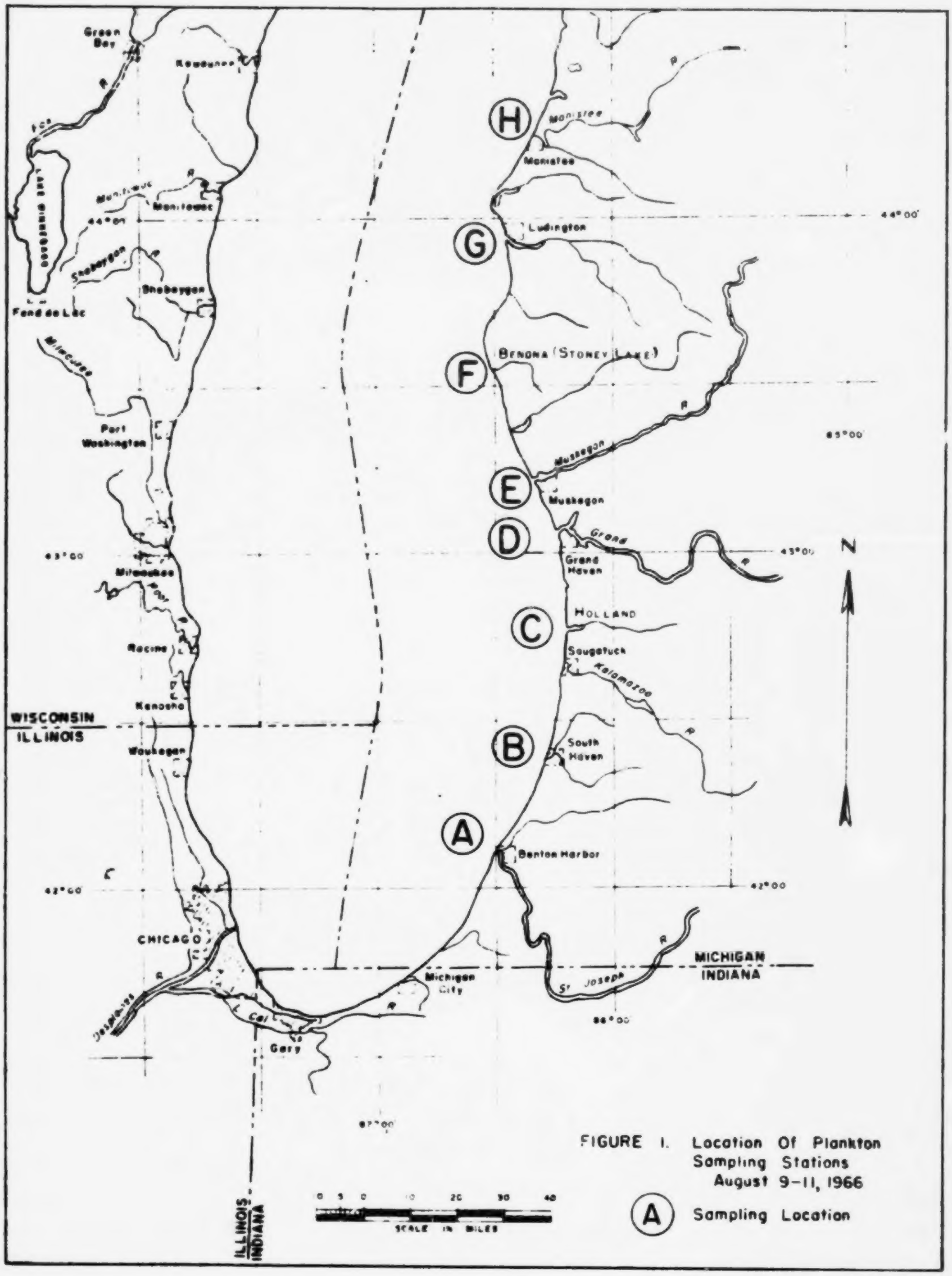
3/17/67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Kewaunee
Fox R
Lake Winnebago
Manitowoc R
Manitowoc
44°00'
Sheboygan R
Sheboygan
Fond du Lac
Milwaukee R
Port Washington
43°00'
Milwaukee
Racine
Kenosha
WISCONSIN
ILLINOIS
Waukegan
42°00'
CHICAGO
Desplaines R
Cal R
Gary
87°00'
ILLINOIS
INDIANA
H
Manistee
Manistee
G
Ludington
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BENONA (STONEY LAKE)
Muskegon R
E
Muskegon
D
Grand R
Grand Haven
C
HOLLAND
Saugatuck
Kalamazoo R
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South Haven
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Benton Harbor
St Joseph R
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MICHIGAN
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86°00'
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N
0 5 0 10 20 30 40
SCALE IN MILES

FIGURE 1. Location Of Plankton Sampling Stations August 9-11, 1966

Ⓐ Sampling Location

FIGURE 2. Total phytoplankton count (summation of all the counts of all four lake stations) at each location compared to the inshore beach tow, Lake Michigan, August, 1966.

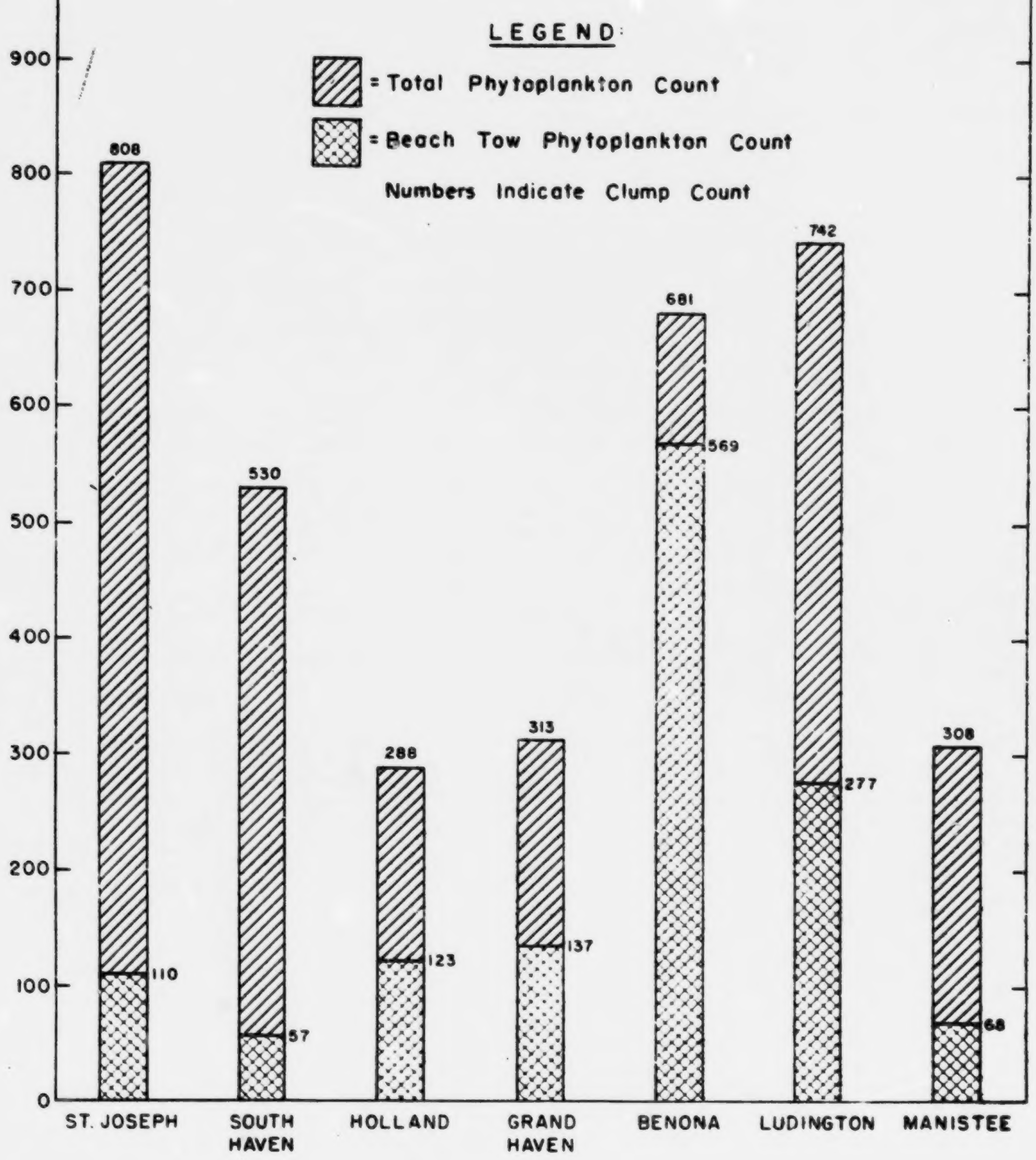
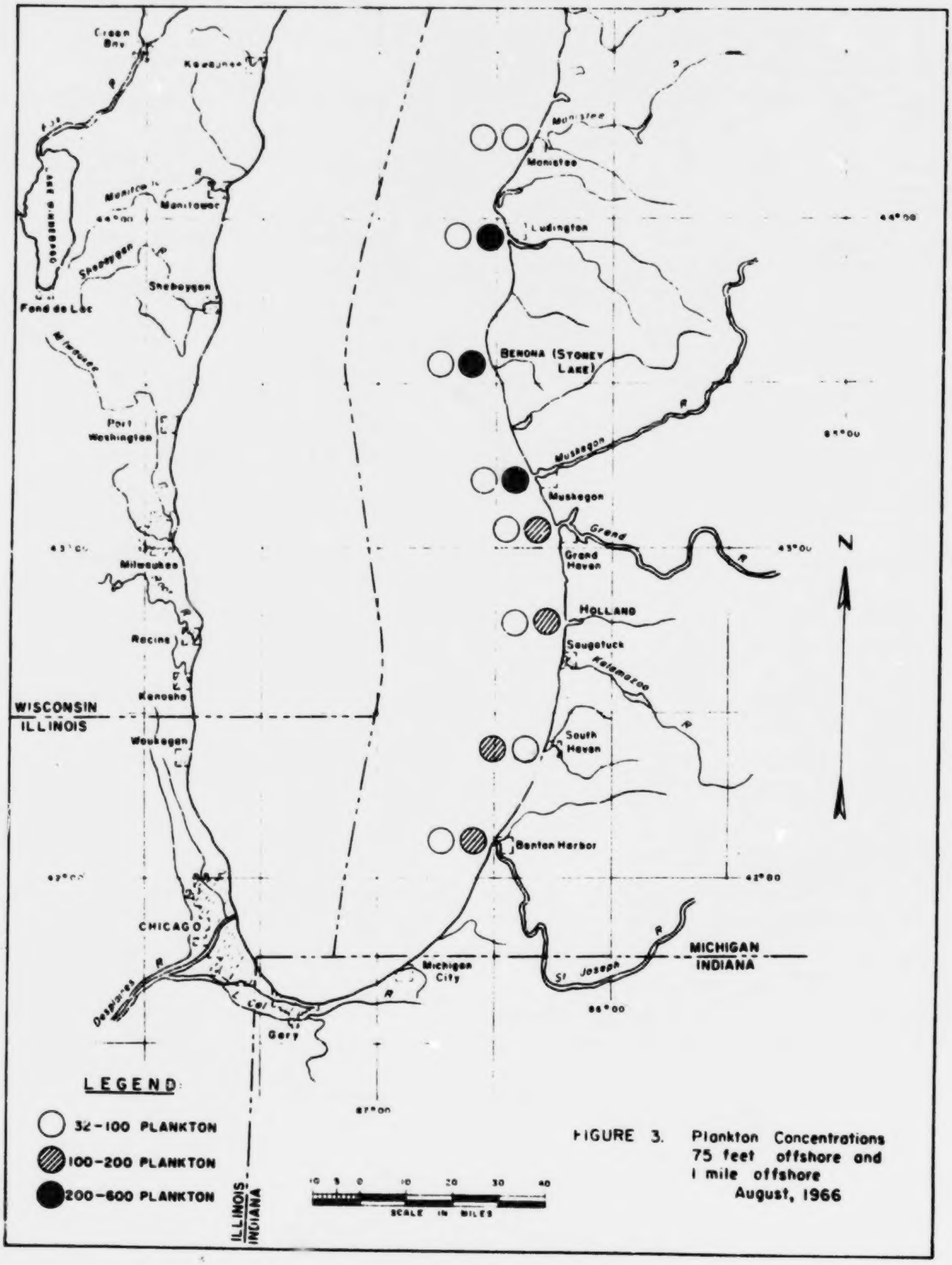


Table 1. Phytoplankton dominants from the mouths of seven tributaries and eight locations near shore in southcentral Lake Michigan, August 9-11, 1966.

		Numerical Dominants				Volumetric Dominants	
Code and Location	Station*	Species	%	Species	%	First	Second
A - St. Joseph	1	Anabaena	27	Ceratium	23	Anabaena	Fragilaria
	2	Anabaena	33	Melosira	22	Melosira	Ceratium
	3	Melosira	52	Anabaena	17	Melosira	Anabaena
	4	Fragilaria	24	Melosira	19	Fragilaria	Melosira
St. Joseph River	5	Melosira	56	Actinastrum	19	Melosira	Pediastrum
B - South Haven	1	Dinobryon	21	Melosira	21	Melosira	Fragilaria
	2	Dinobryon	47	Ceratium	26	Melosira	Ceratium
	3	Melosira	24	Fragilaria	14	Fragilaria	Ceratium
	4	Dinobryon	23	Fragilaria	19	Ceratium	Tabellaria
Black River	5	Navicula	84	Synedra	4	Navicula	Synedra
C - Holland	1	Dinobryon	36	Anabaena	15	Fragilaria	Tabellaria
	2	Fragilaria	36	Dinobryon	25	Fragilaria	Ceratium
	3	Fragilaria	53	Anabaena	13	Fragilaria	Anabaena
	4	Fragilaria	52	Navicula	11	Fragilaria	Navicula
Lake Macatawa	5	Aphanizomenon	73	Pediastrum	12	Aphanizomenon	Pediastrum
D - Grand Haven	1	Fragilaria	33	Dinobryon	20	Fragilaria	Tabellaria
	2	Fragilaria	36	Asterionella	11	Fragilaria	Tabellaria
	3	Fragilaria	35	Tabellaria	24	Spirogyra	Fragilaria
	4	Spirogyra	43	Fragilaria	32	Spirogyra	Fragilaria
Grand River	5	Melosira	27	Pediastrum	16	Melosira	Pediastrum
E - Muskegon	2	Fragilaria	25	Asterionella	22	Fragilaria	Asterionella
	4	Spirogyra	38	Fragilaria	27	Spirogyra	Fragilaria
Muskegon Lake	5	Aphanizomenon	77	Fragilaria	8	Aphanizomenon	Fragilaria
F - Benona	1	Fragilaria	47	Asterionella	21	Fragilaria	Asterionella
	2	Fragilaria	40	Asterionella	30	Fragilaria	Asterionella
	3	Fragilaria	33	Asterionella	32	Fragilaria	Asterionella
	4	Spirogyra	53	Fragilaria	19	Spirogyra	Fragilaria
G - Ludington	1	Fragilaria	59	Asterionella	17	Fragilaria	Asterionella
	2	Melosira	82	Asterionella	7	Melosira	Asterionella
	3	Melosira	69	Fragilaria	21	Melosira	Fragilaria
	4	Melosira	80	Frangilaria	9	Melosira	Fragilaria
Pere Marquette River	5	Melosira	97	Navicula	1	Melosira	Pediastrum
H - Manistee	1	Fragilaria	30	Asterionella	18	Fragilaria	Asterionella
	2	Fragilaria	54	Asterionella	27	Fragilaria	Asterionella
	3	Fragilaria	47	Asterionella	28	Fragilaria	Asterionella
	4	Fragilaria	47	Asterionella	25	Fragilaria	Asterionella
Manistee Lake	5	Fragilaria	20	Anacystis	20	Fragilaria	Anacystis

*Station number refers to distance offshore: 1-one mile; 2-1/3 mile; 3-600 feet; 4-75 feet; 5-river mouth.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Kewaunee
Manitowoc
Lake Winnebago
Sheboygan
Fond du Lac
Milwaukee
Port Washington
Milwaukee
Racine
Kenosha
Waukegan
WISCONSIN
ILLINOIS
CHICAGO
Desplaines R
L. Cal
Gary
Michigan City
MICHIGAN
INDIANA
ILLINOIS
INDIANA
Manistee
Manistee
Ludington
BENONA (STONEY LAKE)
Muskegon R
Muskegon
Grand R
Grand Haven
HOLLAND
Saugatuck
Kalamazoo R
South Haven
Benton Harbor
St. Joseph R
N
44°00
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LEGEND
○ 32-100 PLANKTON
▨ 100-200 PLANKTON
● 200-600 PLANKTON
10 5 0 10 20 30 40
SCALE IN MILES

FIGURE 3. Plankton Concentrations 75 feet offshore and 1 mile offshore August, 1966

FIGURE 2

Table 2. Algal conditions at selected Lake Michigan beaches, August 1966.

Beaches checked	Dominant algae	Nuisance algae type	Nuisance algae concentration	Observations
St. Joseph (Jean Klock Park)	Fragilaria	Anabaena	Sparse	No problem observed
South Haven (City Beach)	Fragilaria	Cladophora	Moderate	Slight problem
Glenn Beach (7 miles north of South Haven)	---	Cladophora	Sparse	No problem observed
Allegan County Park (10½ miles north of South Haven)	---	Cladophora	Moderate	Slight problem
Saugatuck City Beach	---	Cladophora	Sparse	No problem observed
Lakewood Township Park (5 miles north of Saugatuck)	---	Cladophora	Sparse	No problem observed
Holland State Park	Fragilaria	Cladophora	Moderate	Slight problem
Port Sheldon Twp. Park	---	Cladophora	Sparse	No problem observed
Grand Haven State Park	Spirogyra	Spirogyra Cladophora	Abundant	Moderate problem observed
Norton Township Park (6½ miles south of Muskegon)	---	Spirogyra Cladophora	Very abundant	Severe problem observed
Muskegon State Park	Spirogyra	Spirogyra Cladophora	Abundant	Moderate problem observed
Lloyd Park (12 miles north of Muskegon)	---	Cladophora	Sparse	No problem observed
Meinert Twp. Park (17 miles N of Muskegon)	---	Spirogyra Cladophora	Very abundant	Severe problem observed
Benona Beach (25 miles N of Muskegon)	Spirogyra	Spirogyra Cladophora	Very abundant	Severe problem observed
Little Sable Point (6½ miles N of Benona)	---	Cladophora	Abundant	Moderate problem observed
Cedar Point Twp. Park (6 miles N of Little Sable Point)	---	Cladophora	Abundant	Moderate problem observed
Pentwater State Park Beach	---	Cladophora	Sparse	No problem observed
Ludington City Beach	Melosira	None	---	Clean water
Manistee	Fragilaria	None	---	Clean water

Tabel 3. Soluble orthophosphate concentrations as PO_4 in mg/l along the southeast-central Lake Michigan shoreline and in nearby tributaries, August 9-11, 1966.

Area Location	Sample Stations				
	1 Mile Off Shore	1/3 Mile Off Shore	600 Feet Off Shore	75 Feet Off Shore	River Sample
1. St. Joseph 8-9-66	0.01	0.00	0.01	0.02	0.19
2. South Haven 8-10-66	0.01	0.00	0.00	0.01	0.56
3. Holland 8-10-66	0.00	0.01	0.01	0.00	0.17
4. Grand Haven 8-10-66	0.00	0.00	0.00	0.00	0.36
5. Muskegon 8-10-66	0.01	No sample	No sample	0.01	0.16
6. Benona 8-10-66	0.00	0.00	0.01	0.00	No significant tributary
7. Ludington 8-11-66	0.00	0.00	0.00	0.00	0.03
8. Manistee 8-11-66	0.01	0.00	0.00	0.01	0.01

Table 4. Plankton composition from the mouths of seven tributaries and eight locations near shore in southcentral Lake Michigan, August 9-11, 1966. Numbers indicate the frequency of occurrence of organisms or clumps in 10 fields at 100 power.

Genera	ST. JOSEPH				ST. JOSEPH RIVER	SOUTH HAVEN				BLACK RIVER	HOLLAND				LAKE MACATAWA	GRAND HAVEN				GRAND RIVER	MUSKEGON		MUSKEGON LAKE	BENONA (STONEY LAKE)				LUDINGTON				PERE MARQUETTE RIVER	MANISTEE				MANISTEE RIVER
Phytoplankton	A1*	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5	D1	D2	D3	D4	D5	E2	E3	E5	F1	F2	F3	F4	G1	G2	G3	G4	G5	H1	H2	H3	H4	H5
Non-Flagellate Greens																																					
Actinastrum	P**	2	28	6	119			18						1						11		1															
Ankistrodesmus		P		P											1					2																	
Botryococcus											P												2								1						
Charella								4				1														4											
Chlorococcum					3																									1	P			P			
Closterium				P	1													P																			
Coelastrum											P				1			P	P				P					P					4				
Dictyosphaerium	P	P						P	P							2	P	P	1		P		P	P	P		P				1						
Dimorphococcus								1				1													P												
Euastrum															1																						
Gloeocystis							1	P		1																P		P									
Micractinium														1																							P
Oocystis												1	1			P		P	P					P	P					P			P			P	P
Pediastrum	2	13	14	7	27	7	1	15	3	P		2	1	4	25	4	1	3	2	17	1	2	10		1	2	1	P	P	P		P	2	2	1	P	
Planktosphaeria																				1																	
Scenedesmus			4	2	29									2	1					7	1	2					P										
Selenastrum						P																															
Sphaerocystis								3																					1	2							
Staurastrum	P			P										1									2					P									
Westella																																					
Totals	2	15	46	15	179	7	2	41	3	1	0	5	2	9	29	6	1	3	3	38	2	4	14	0	1	6	1	0	1	3	2	0	6	2	1	0	0
Flagellate																																					
Ceratium hirudinella	11	25	13	6		23	32	16	4		5	5		3		5	2	1			8	1	P	2	P			4	P	4			5	4			1
Eudorina	P		8	2				P	P	2		P								2		P	2				3			P	1	P		1	P	1	1
Glenodinium																												P	P			1					
Gonium					1																																
Pandorina																		P		2			1								2						
Peridinium						6					4	4		5		6	3		1		1						1		P	2	1	2					
Pleodorina		P			11	2							1						P		P									P							
Totals	11	25	21	8	12	31	32	16	4	2	9	9	1	8		11	5	1	1	4	9	1	3	2	0	0	4	4	0	6	4	3	9	6	0	1	2
Filamentous - Greens																																					
Oscillatoria					P					P																	P										
Spirogyra														1			1	2	59		2	82				2	300				1						
Ulothrix	2								2					1						3																	
Totals	2		0	0	0	0	0	0	2	0	0	0	0	2	0	0	1	2	59	3	2	82	0	0	0	2	300	0	0	0	1	0	0	0	0	0	0
Yellow-Green																																					
Dinobryon	11	66	7			28	58	29	13		19	15	7	7		19	5		2		10	4		2						1			9	2	1	2	1
Diatoms																																					
Centrics																																					
Cyclotella				4	6											1	1		P					1			P			P	P				2	4	
Melosira sp.		80	152	21	352	28	4	57	4		1			2		1				29			2				2	1	101	195	221	245	3	P	4	2	2
Stephanodiscus							P		P				P	1					P																P	1	
Totals		80	152	25	358	28	4	57	4		1			3		2	1			29			2	1			2	1	101	195	221	245	3		6	7	2
Pennates																																					
Asterionella		4		2		3	3	2	2	P	3	1	2	4		7	5	6	13		17	18	1	7	6	19	94	10	9	18	5		14	20	24	17	2
Cymbella										2																											
Diatoma										4													1					2			1						
Diatomella			2	4	7																																
Fragilaria	7	34	9	26	2	22	13	32	11	1	6	21	28	64	1	31	16	13	44	17	20	58	22	15	8	20	109	35	8	59	25	2	24	40	41	32	3
Gyrosigma kutzingii																																					1
Navicula						2	1			77			1	13					4	2	1	4		2			P				13	3			6	4	1
Synedra		12	9	14	71	3	2	10	2	4		2	1	1					1			2		P		1	4				1		1	1	3	3	
Tabellaria	1	4		4		3	4	25	1		6		3	6	1	11	6	9	7	2	10	17		1	1	3	52	P		1	1		2	1	3	2	
Totals	8	54	20	50	80	33	23	69	26	88	15	24	35	88	2	49	27	28	69	21	48	119	24	25	15	41	259	47	17	78	46	5	41	62	77	58	7
Blue-Greens																																					
Anabaena	13	119	50	2	1	2	3	24	5	1	8	4	7	4	15	8	4	3	1		2	1	12	2	4	5		7	3				11	1	2	P	
Anacystis	P	P			1	P	1	P			1		1	1	9		P	P			3		4		P	1	3	P	1		P		P	1		P	3
Aphanizomenon															146								209														P
Aphanocapsa	1													1	P					4	P		P								1			P			
Coelosphaerium	P		P		P	2		P													P			P	P		P										
Gomphosphaeria		P	2	3	1	2	1	P	P		P	2		P		P	P		2	8	3	3	4	P	P	P		P	P							P	
Lyngbya																		P								3	P		P								
Merismopedia																		P									P	P		P	2						
Totals	14	119	52	5	3	6	5	24	5	1	9	6	8	6	170	8	4	3	3	12	8	4	229	2	4	9	3	7	4	0	3	0	11	2	2	0	3
Protozoa	2	5	7	6	21	8	10	14	1			1	1	4	3	2				2	2		1		P												1
Cladocera	P			3		2	2	2	2	P	3	3	5	6	5	4	1	2	3		1	P	2	1		1	P	P	1	1			2	1	1		P
Copepoda		P			P	2	1	2			1	2	2	5	12	1	1	1	2	2	2		1		P			P		P					P		
Nauplius larvae	P	2			P	3	3	2		1	3	1	2	2	1	1	1				1								P	P		P					1
Rotifers	2	18	33	11	6	35	10	25	4	1	9	12	30	23	22	20	25	12	14	5	16	10	4	5	10	6	1	3	3	2	5	12	1	2	12	5	1
Total zooplankton	4	25	40	20	27	50	26	45	7	2	16	19	40	40	43	28	28	15	19	9	22	10	8	6	10	7	1	3	4	3	5	12	3	3	13	5	3
Total phytoplankton	48	359	291	110	632	133	124	236	57	92	53	59	53	123	201	95	44	37	137	107	79	215	272	32	20	60	569	59	123	283	277	253	79	74	87	68	15
Total plankton	52	384	331	130	659	183	150	281	64	94	69	78	93	163	244	123	72	52	156	116	101	225	280	38	30	67	570	62	127	286	282	265	82	77	100	73	18
Total species	17	19	14	20	21	20	18	24	16	14	15	17	16	25	16	17	16	18	19	17	21	15	21	14	15	14	20	18	14	17	18	8	13	14	14	15	16

*The station numbers indicate the following distances offshore: 1 - 1 mile; 2 - 1/3 mile; 3 - 600 feet; 4 - 75 feet.

**'P' indicates that the organism was present but not counted for quantitative purposes.

APPENDIX L

SUMMARY OF BACTERIOLOGICAL DATA
FOR
LAKE MICHIGAN WATERS

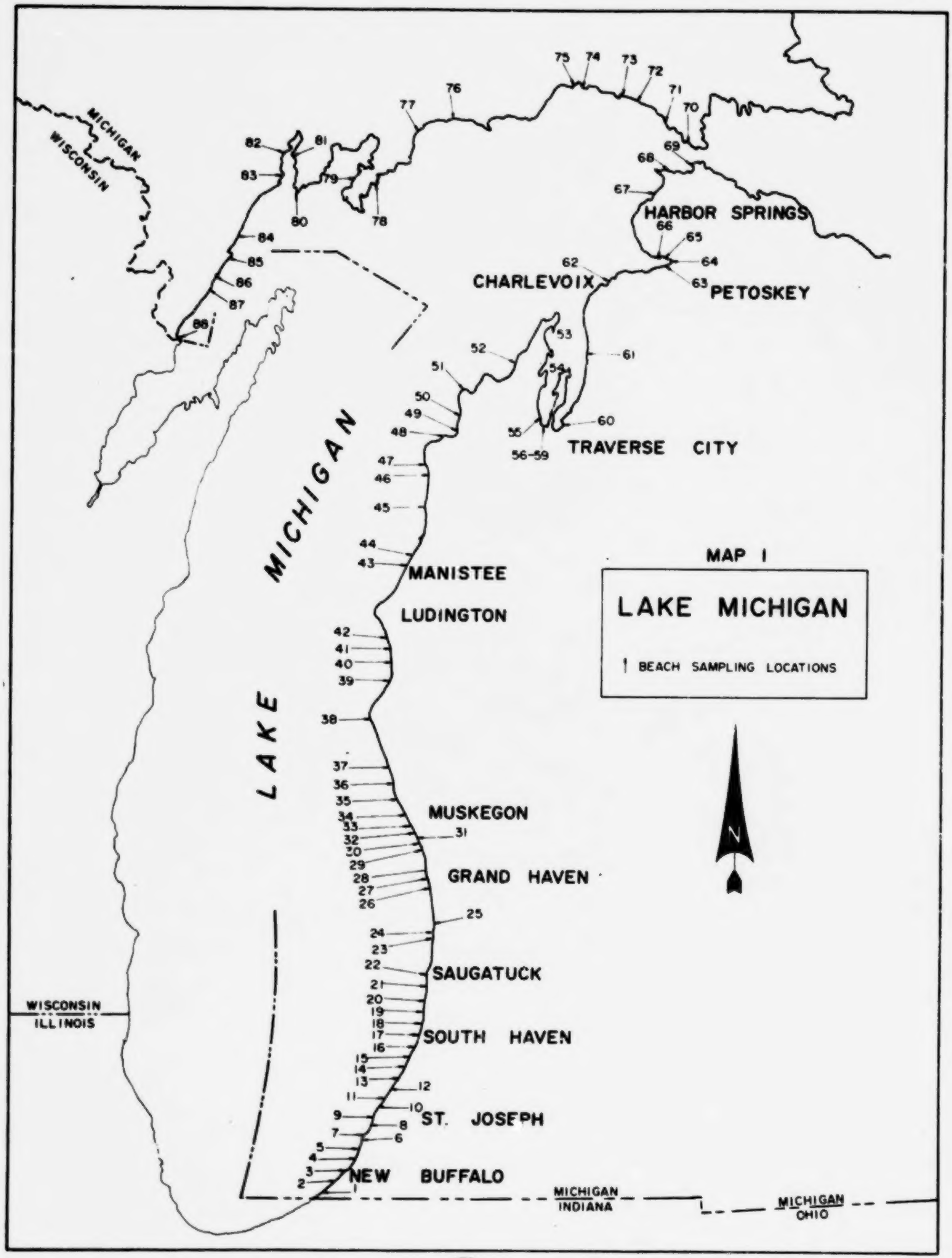
MAP 1
LAKE MICHIGAN
BEACH SAMPLING LOCATIONS
LAKE MICHIGAN
MICHIGAN
WISCONSIN
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
MICHIGAN
OHIO
N
HARBOR SPRINGS
CHARLEVOIX
PETOSKEY
TRAVERSE CITY
MANISTEE
LUDINGTON
MUSKEGON
GRAND HAVEN
SAUGATUCK
SOUTH HAVEN
ST. JOSEPH
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FIGURE 1

BACTERIOLOGICAL DATA
for
LAKE MICHIGAN WATERS
along
MICHIGANS LOWER PENINSULA COASTLINE
1966 & 1967

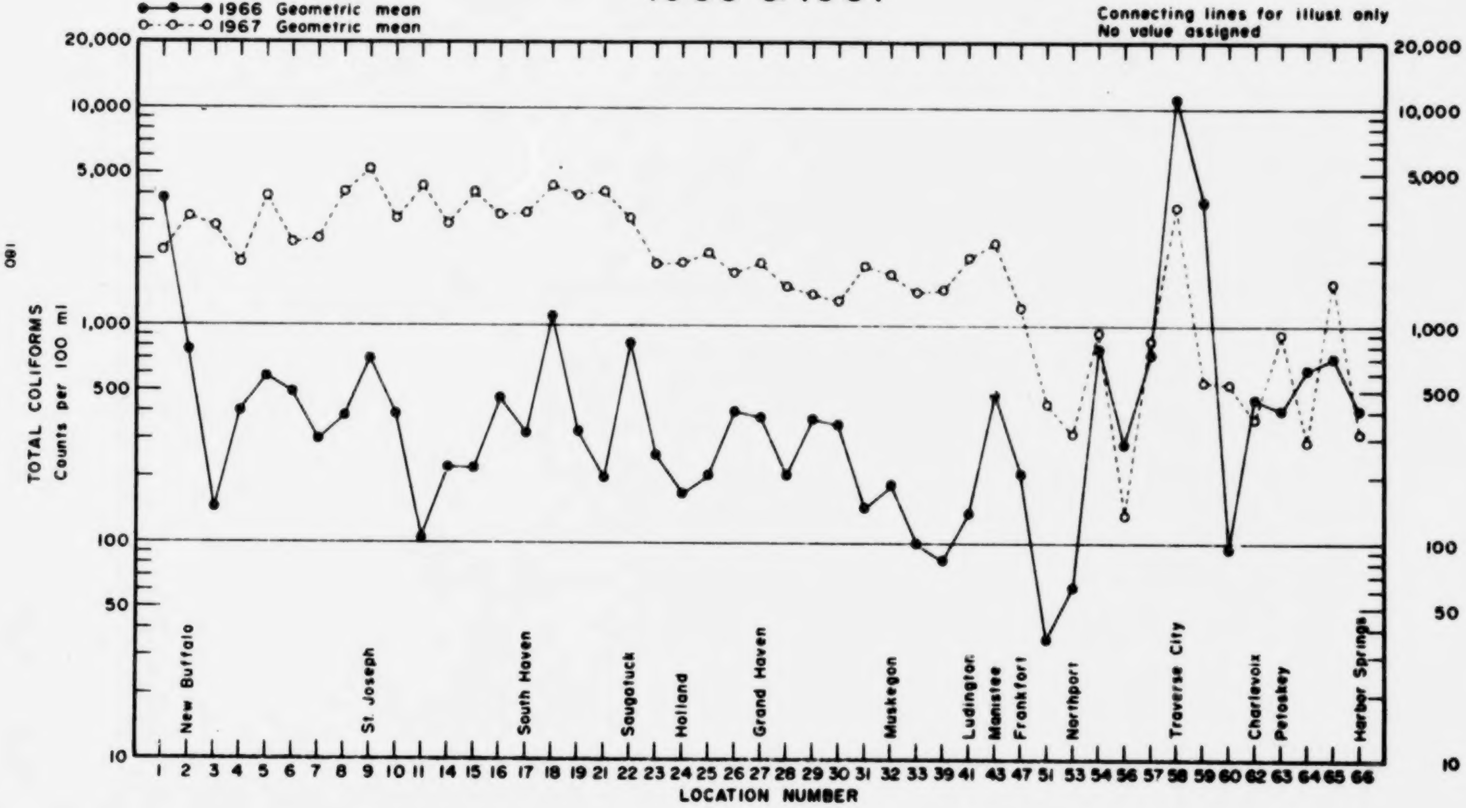


Table 1

SUMMARY OF BACTERIOLOGICAL DATA FOR LAKE MICHIGAN WATERS
ALONG MICHIGAN'S LOWER PENINSULA COASTLINE
1966 and 1967

Sampling Locations	1966 Results				1967 Results			
	Min.	Max.	Geo. Mean	No. of Samples	Min.	Max.	Geo. Mean	No. of Samples
1. Grand Beach	430	46,000	3,800	5	200	34,000	2,211	6
2. New Buffalo	< 30	46,000	774	5	700	39,000	3,149	6
3. Harbert Beach	< 30	930	146	4	700	19,000	2,841	6
4. Warren Dunes State Park	< 30	4,300	406	20	100	19,000	1,976	24
5. Weko Beach	91	4,300	583	5	600	13,000	3,941	6
6. Glenlord Beach	< 30	2,400	498	5	700	6,000	2,420	6
7. Pine Beach	< 30	4,300	300	15	400	19,000	2,536	18
8. Silver Beach	< 30	9,300	385	20	400	500,000	4,114	42
9. St. Joseph	> 30	9,300	717	25	800	1,700,000	5,276	30
10. Jean Klock Park	< 30	9,300	390	25	200	21,000	3,138	30
11. Berrien Co. Park	> 30	2,300	105	5	600	17,000	4,424	6
12. Hager Twp. Park	--	--	--	--	1,100	78,000	3,409	6
13. Roadside Park	--	--	--	--	2,300	17,000	4,919	6
14. Covert Twp. Park	< 30	2,400	223	5	600	100,000	2,968	6
15. Harry LaBar Drake Recreation Area	> 30	1,500	222	5	1,100	10,000	4,113	6
16. 13th Ave. Pk. South Haven	150	2,400	467	5	1,600	6,200	3,251	6
17. South Haven	< 30	9,300	318	45	200	500,000	3,324	60
18. Glenn	150	9,300	1,111	5	1,600	10,000	4,404	6
19. Allegan Co. Park	< 30	2,400	327	5	600	16,000	4,027	6
20. Ganges Twp. Park	--	---	--	--	700	18,000	4,047	6
21. Douglas Beach	36	4,300	202	9	500	25,000	4,161	12
22. Saugatuck Oval	36	9,300	834	15	500	13,000	3,125	18
23. Macatawa Park	< 30	1,500	256	10	600	37,000	1,923	12
24. Lake Macatawa Outlet	36	1,500	169	9	< 100	65,000	1,953	12
25. Holland State Park	< 30	2,300	206	24	12	77,000	2,148	30
26. Grand Haven State Park	36	7,500	407	25	< 100	45,000	1,759	36
27. Grand Haven Beach	< 30	4,300	383	20	< 100	34,000	1,951	24
28. North Beach Park	< 30	9,300	206	10	< 100	48,000	1,513	12
29. Norton Twp. Park	< 30	21,000	372	5	< 100	31,000	1,391	6
30. Lake Harbor	< 30	9,300	348	12	< 100	61,000	1,306	24
31. Muskegon City Park	36	930	145	10	< 100	37,000	1,888	12
32. Pere Marquette Park	< 30	2,400	185	35	< 100	53,000	1,730	42
33. Muskegon State Park	< 30	930	99	20	< 100	17,000	1,438	24
34. Pioneer Co. Park	--	--	--	--	< 100	3,400	3,089	6
35. Duck Lake Outlet	--	--	--	--	< 100	18,000	7,734	12
36. Lloyd Park	--	--	--	--	100	5,200	6,686	6
37. Meinert Park	--	--	--	--	< 400	45,000	3,449	6
38. Little Sable Pt.	--	--	--	--	< 200	15,000	1,556	6
39. Mears State Park	< 30	930	[illegible]	15	< 100	22,000	1,148	18
40. Summit Twp. Park	--	--	--	--	400	35,000	3,566	6
41. Stearns City Park	< 30	4,300	137	45	< 100	60,000	2,055	54
42. Ludington State Park	--	--	--	--	< 100	18,000	1,442	15
43. Manistee	< 30	24,000	485	45	< 100	40,000	2,410	42
44. Orchard Beach State Park	--	--	--	--	< 100	5,600	605	12
45. Arcadia	--	--	--	--	< 100	27,000	385	6
46. Elberta	--	--	--	--	< 100	50,000	1,297	24
47. Frankfort	30	24,000	207	45	< 100	2,800,000	1,229	30
48. Lake Twp. Park	--	--	--	--	< 100	9,000	270	10
49. Benzie State Park	--	--	--	--	< 100	630,000	891	18
50. Empire Park	--	--	--	--	< 100	10,000	231	18
51. D. H. Day State Park	< 30	91	36	15	< 100	50,000	438	18
52. Leland Twp. Park	--	--	--	--	200	26,000	1,938	6
53. Northport Mun. Beach	< 30	230	63	10	< 100	80,000	318	12
54. Suttons Bay Village Park	36	>140,000	783	10	< 100	17,000	935	12
55. Elmwood Twp. Park	--	--	--	--	100	22,000	1,370	6
56. Traverse City Mun. Park	< 30	7,500	285	13	< 100	110,000	134	12
57. Clinton Beach	< 30	9,300	741	15	< 100	90,000	850	18
58. Sunset Beach	4300	140,000	11,080	5	200	120,000	3,510	6
59. Bryant Beach	430	110,000	3,709	5	< 100	38,000	549	6
60. Traverse City State Park	< 30	930	94	15	< 100	860,000	544	18
61. Barnes Twp. Park	--	--	--	--	< 100	670,000	637	6
62. Charlevoix City Park	< 30	100,000	461	30	< 100	32,000	377	36
63. Bay View Recreation Club	< 100	1,200	413	5	< 100	30,000	914	6
64. Petoskey City Beach	100	50,000	631	5	< 100	3,100	292	6
65. Wequetonsing	< 100	40,000	719	5	300	460,000	1,579	6
66. Harbor Springs Mun. Beach	< 100	40,000	413	10	< 100	1,700	322	6
67. Bliss Twp. Park	--	--	--	--	< 100	1,600	159	6
68. Wilderness State Park	--	--	--	--	< 100	1,100,000	475	12
69. Mackinac City Mun. Park	--	--	--	--	< 100	1,700	315	12

Note: 1966 results are expressed as MPN per 100 ml.
1967 results are expressed in organisms per 100 ml.

TABLE 2

UPPER PENINSULA BACTERIOLOGICAL DATA TABULATION

Sampling Location	7-7-67	7-9-67	7-17-67	7-18-67	7-19-67	7-24-67
70. State Roadside Park, W. of Gros Cap		36	2,300			
71. Lake Michigan Picnic Grounds, S.E. of Brevoort			91			
72. Roadside Park at Cut River Bridge		36	930			
73. Twp. Camp Ground at Epoufette		36	150			
*74. State Roadside Park E. of Naubinway		91	210			
			230			
75. End of Public Access Road-Naubinway		91	230			
76. Dutch John's Point Park					210	
77. State Roadside Park N.E. of Thompson					230	
78. Portage Bay Forest Campground						4,300
*79. Fayette State Park					91	
					91	
					930	
80. Peninsula Point Campground				91		
81. Twin Springs Park						24,000
82. Gladstone Beach						4,300
*83. Ludington Beach, Escanaba				230		
				230		
				230		
*84. Fox Park, Menominee County	930			1,500		
				1,500		
*85 J. W. Wells State Park	230			430		
	36			1,500		
				4,300		
86. Menominee County Park, Fowler Creek	750			1,500		
87. Menominee County Park, Rochereau Creek	93			930		
88. Henes Park, Menominee County	150			[illegible],500		

Note: Results reported in MPN/100ml.

*These locations were sampled at more than one location along the beach.

APPENDIX M

BIOLOGICAL SURVEYS IN THE VICINITY
OF THE
E. I. DU PONT DE NEMOURS AND COMPANY DISCHARGE
TO
LAKE MICHIGAN

Biological Surveys in the Vicinity of the
E. I. duPont de Nemours and Company Discharge
to Lake Michigan, Montague, Michigan
September 10, 1957 and September 6, 1967

In September 1957 and 1967 biological surveys were conducted in the vicinity of the E. I. duPont de Nemours and Company (duPont) discharge to Lake Michigan. The purpose of these surveys was to determine the effects of the discharge upon the biota in this area.

Bottom-associated organisms and their community structures are particularly useful in evaluating the effects of wastes on aquatic life. Some species of aquatic animals spend their entire life cycle in association with the lake bottom while other species have stages (egg, larval and/or pupal) dependent on the aquatic environment for varying periods (from as short as 2 weeks to more than a year). Therefore the individuals in a benthic community have been exposed to their aquatic environment for extended periods of time. Their populations reflect the long-term water quality conditions to which they have been exposed.

Benthic animals are important in the food chain of fish. Desirable sport fish are companion species of benthic macroinvertebrates typically found in environments with good water quality. Healthy populations of bottom organisms provide the proper bases of the food chain to support populations of desirable sport fish. Water quality changes sufficient to alter the benthic community will also alter the fish population.

METHODS

Quantitative (areal) samples and some qualitative collections of the bottom-dwelling macroinvertebrates were made with a Petersen dredge in 1957 and a Ponar dredge in 1967 (Figures 1 and 2). U. S. Standard #30 brass screens were used for sieving these samples. Samples were fixed with formalin and labeled as collected. Samples were washed and sorted and the organisms were identified and tabulated in the Lansing laboratory (Tables 1 and 2). Animals were assigned a tolerance status according to published accounts and/or the past experience of the authors. Tolerance status refers to the animal's relative ability to withstand and/or respond to adverse environmental conditions. Individual tolerances are generally derived from an animal's reaction to organic wastes and attendant oxygen depletion or modification of bottom deposits.

Tolerance status may be generally defined as:

Tolerant - organisms that can grow and develop within a wide range of environmental conditions. They are often found in water of poor quality. These species are generally insensitive to a variety of environmental stresses.

Intolerant - organisms whose growth and development are dependent upon a narrow range of optimum environmental conditions. They are rarely found in areas of organic enrichment. They cannot adapt to adverse stiuations and are replaced by less sensitive organisms if the quality of their environment is degraded.

Facultative - organisms with the ability to survive over a wide range of conditions. They possess "medium" tolerance and often respond positively to moderate organic enrichment but cannot tolerate severe environmental stresses.

In addition to tolerance status, the diversity of animals present in a given benthic community is significant. In general, pollutional communities are characterized by very low species diversity, while normal undisturbed communities contain many different species.

In 1957 and 1967 water samples were collected for chemical analysis at each bottom sampling station (Tables 3 and 4).

Observations and Results

Benthos

The Federal Water Pollution Control Administration (FWPCA, 1963) found that 3 types of organisms dominated the benthos in Lake Michigan. Amphipods (scuds) were the most abundant, followed by sludgeworms (oligochaets), and then midges (tendipedids) which were moderately abundant.

The intolerant scud (*Pontoporeia affinis*) prefers a habitat of sand or gravel and is not numerous in organic sediments. Oligochaets, on the other hand, thrive in areas of organic decomposition which may result from organic waste discharges. For this reason an increase in oligochaets accompanied by a decline in amphipods in the vicinity of organic waste discharges is considered evidence that the environment is adversely affected.

A tabulation was made to compare the percent of amphipods, oligochaets and midges reported by the FWPCA throughout Lake Michigan and by the Michigan Water Resources Commission (MWRC) in the vicinity of the duPont outfall (Table 5). This comparison shows that the percent of intolerant amphipods is similar in the 4 studies reported. Pronounced differences occurred in the percent of midges and worms. This could be influenced by the difference in sampling areas. Eggleton (1935) and FWPCA sampled over a large area of Lake Michigan. We confined our sampling to depths of less than 50 feet.

Table 5

Amphipods, oligochaets and midges in benthos samples
from Lake Michigan, 1931, 1957, 1962, and 1967

Source	Year	Percent Amphipods	Percent Oligochaets	Percent Midges	Percent* Miscellaneous	Average no./m^2
Eggleton	1931	65	24	--	11	1,243
MWRC	1957	66	6	25	3	3,002
FWPCA	1962	48	39	--	13	4,229
MWRC	1967	60	8	30	2	4,756

*Midges are included in miscellaneous by the FWPCA. They also cited Eggleton's data in this manner.

In 1957 3 of the 10 samples (4, 5, and 6; Figure 1) were collected from the immediate vicinity of the duPont discharge. Stations 1, 2 and 3 were approximately 1/2 mile south and stations 7, 8, and 9 were 1/2 mile north at varying distances offshore. Station 10 was taken just off the mouth of the White Lake Channel. In general, the species composition was similar at all stations (Figure 3).

In the sample collected nearest duPont's discharge (station 6) the number of amphipods was noticeably lower than at similar depths elsewhere (Table 1), 7/sq. foot versus 48 and 156/sq. foot. It should be noted, however, that this location was closer to shore than the other stations and could have been subject to unstable substrate sands. This was apparently the situation at station 1 in only 4 feet of water 250 feet from shore where only 10 midges of 3 species were found.

In 1967 11 bottom samples were taken within 500 feet of duPont's discharge and 7 from 1 mile or more distant (Figure 2). There was a great deal of similarity between the number of species and their tolerance status from these 2 areas (Figure 4), as there was in 1957. Intolerant amphipods were present at all 11 stations within 500 feet of the discharge but their abundance was less, 105/sq. foot compared to 521/sq. foot for those stations more than 500 feet from the discharge. Proximity to the discharge is apparently not the only factor affecting amphipod abundance. Average sample depth in the discharge area was 18 feet and 28 feet in the control area. There appears to have been a direct relationship between depth and amphipods: with greater depth more amphipods were present (Figures 5 and 6).

Reconnaissance surveys of the aquatic fauna were conducted in the discharge vicinity in 1961 and 1963. There has been no apparent injury in the immediate discharge area or remote from it. Amphipods and midges have been the dominant animals. Minnows and alewives have been observed swimming normally in the discharge as it bubbles to the surface.

Bottom materials have been of fine, clean sand with no deposit on all 4 inspections.

Water Quality

In conjunction with the benthos studies water samples have been analyzed in 1957 and 1967 (Tables 1 and 2). Waste contaminants have always been well within the MWRC Order of Determination.

Water samples taken directly over the discharge in September 1967 contained 0.65 mg/l ammonia. No ammonia was detected 100 feet in any direction from the discharge. All other water quality parameters measured were very near normal in all sampling locations.

SUMMARY

1. Biological surveys were conducted in 1957 and 1967 to determine if the E. I. duPont wastewater discharge to Lake Michigan had any effect on the surrounding bottom fauna populations.
2. These studies indicate that the discharge has not had a significant effect on the benthic communities. Intolerant species were present at all stations regardless of proximity to the discharge.
3. Water samples were collected and analyzed at all bottom sampling stations. The waste constituents of the duPont discharge could not be detected 100 feet from the outfall.

1957 Field and laboratory work by:	Carlos M. Fetterolf, Jr., Aquatic Biologist Edwin S. Shannon, Sanitary Engineer
1967 Field work by:	D. James Seeburger, Aquatic Biologist Ronald B. Willson, Aquatic Biologist
1957 and 1967 Chemical analyses by:	Russell Krueger, Chemist
1967 Laboratory work and report by:	D. James Seeburger Water Quality Appraisal Unit Michigan Water Resources Commission Michigan Department of Conservation

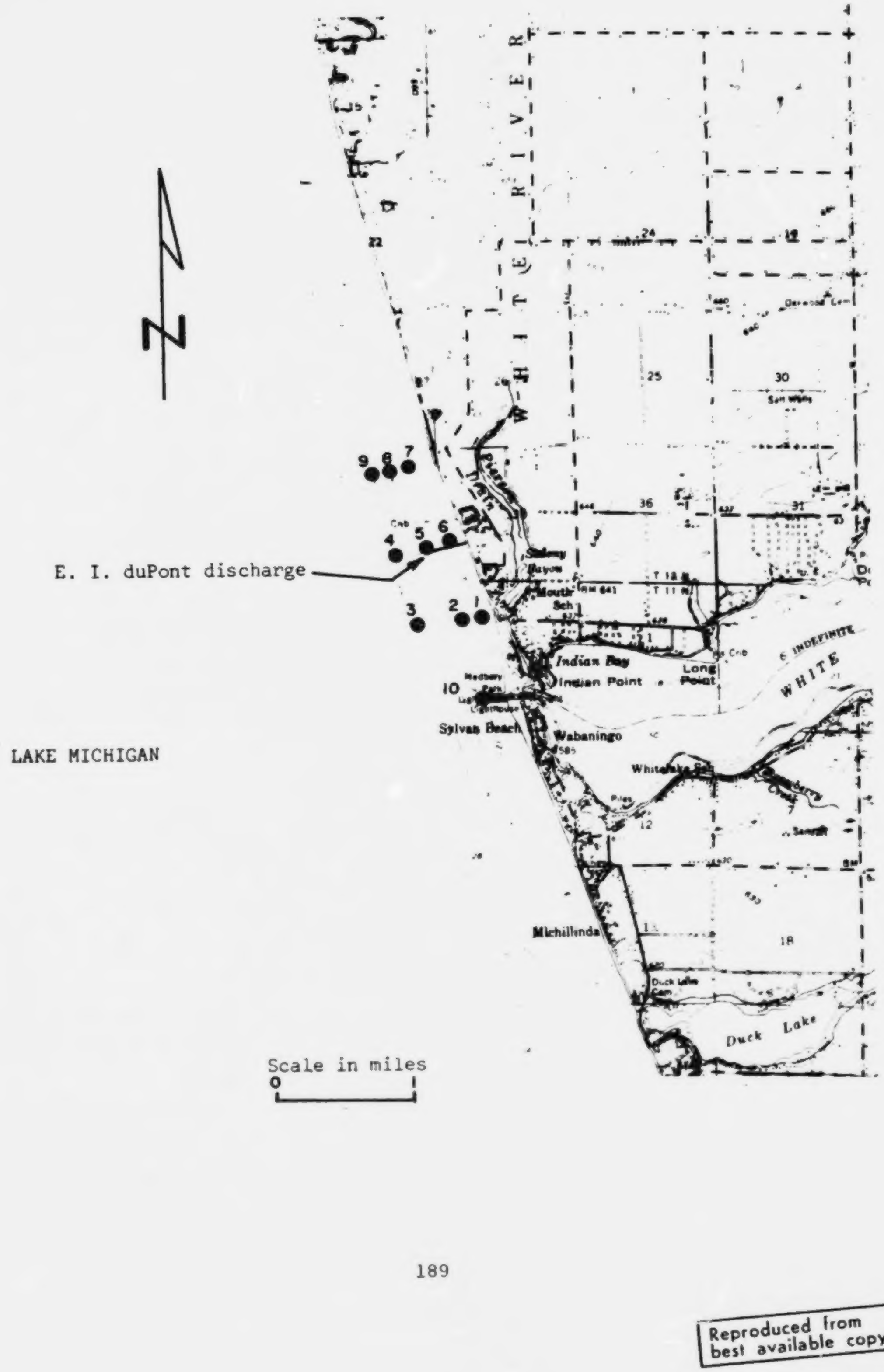
January 26, 1968

Literature Cited

Eggleton, F. E. 1935. The deep-water bottom fauna of Lake Michigan. Papers of the Michigan Academy of Science, Arts and Letters, Vol. XXI, (1935). pp. 599-612 as cited by FWPCA, 1963

FWPCA, 1963. Lake Michigan studies. Special report number LM-4, Biological Studies. FWPCA, Division of Water Supply and Pollution Control, Great Lakes-Illinois River Basins Project. pp. 1-20.

Figure 1. Combined chemical and bottom fauna sampling station vicinity of duPont discharge Montague, Michigan, September 10, 1957. From U.S.G.S. quadrangle.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6
E. I. duPont discharge
3
2
1
Indian Bay
Indian Point
Long Point
10
Sylvan Beach
Wabaningo
WHITE
INDEFINITE
Whitelake
LAKE MICHIGAN
Michillinda
Duck Lake
24
25
30
36
31
12
18
Scale in miles
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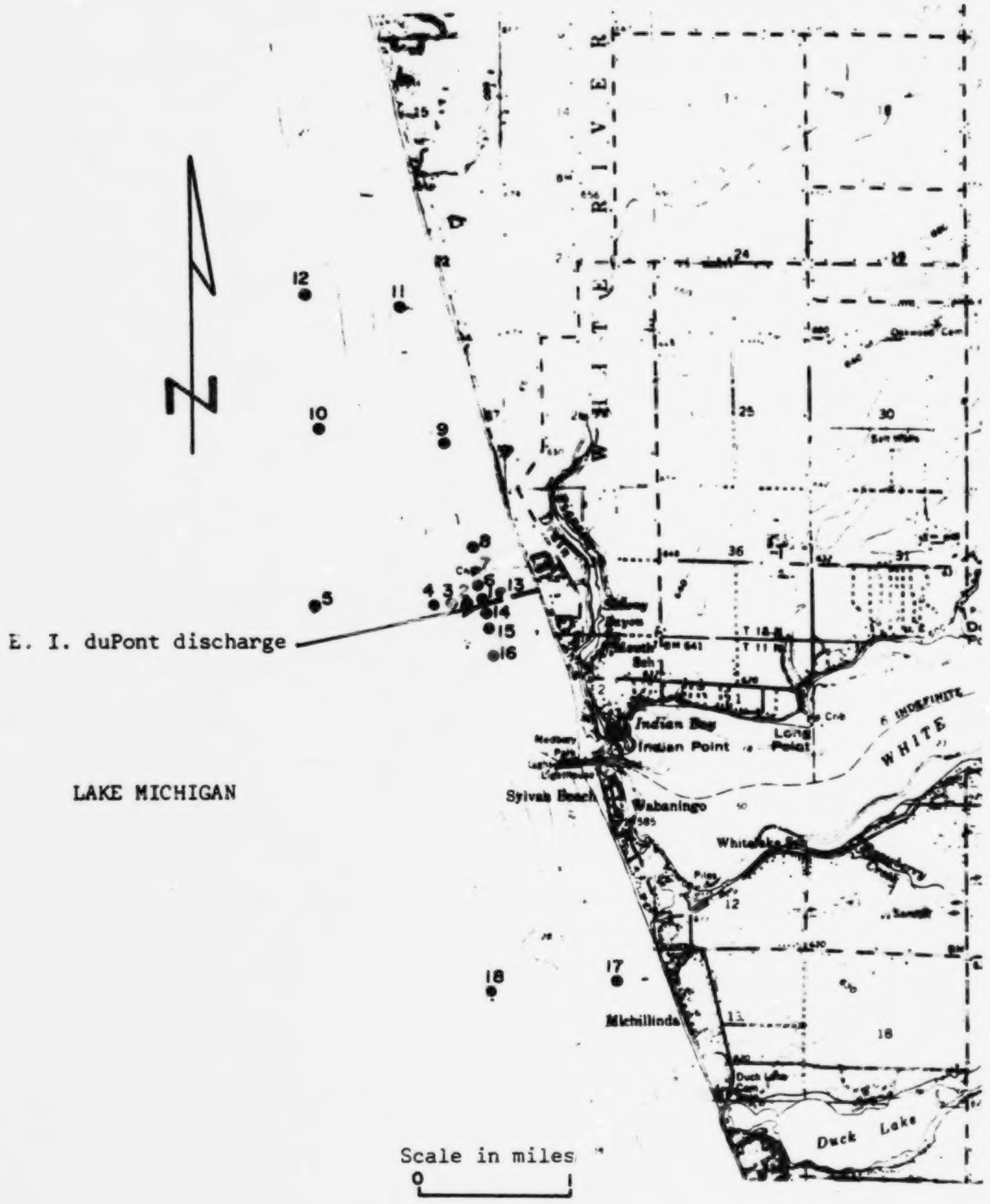
Figure 2. Combined chemical and bottom fauna sampling stations, duPont discharge and vicinity, Montague, Michigan, September 6, 1967. From U.S.G.S. quadrangle.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E. I. duPont discharge
LAKE MICHIGAN
RIVER
WHITE
Indian Bay
Indian Point
Long Point
Sylvan Beach
Wabaningo
Michillinda
Duck Lake
Scale in miles
0
1

Table 1. Quantitative survey of benthic macroinvertebrates, Lake Michigan, vicinity of E. I. duPont discharge near Montague, September 10, 1957.

	Station Depth	1 4'	2 12'	3 21'	4 24'	5 18'	6 12'	7 12'	8 18'	9 22'	10 18'
	Distance offshore Distance along shore from discharge	250' 1/2 mi. S.	1,000' 1/2 mi. S.	2,000' 1/2 mi. S.	2,000' at discharge	1,500' at discharge	500' at discharge	800' 1/2 mi. N.	1,200' 1/2 mi. N.	2,000' 1/2 mi. N.	White Lake Channel 1 1/8 mi. S.
	Tolerance status[1] and species	Number of animals per square foot									
T	Oligochaeta (aquatic earthworms)	---	1	12	9	37	29	1	39	13	32
	Mollusca (snails and clams)										
I	*Somatogyrus* sp.	---	---	---	---	---	---	---	---	---	3
F	*Valvata* sp.	---	---	19	1	---	---	---	---	12	---
T	*Sphaeriidae*	---	---	3	---	---	---	---	1	---	17
	Turbellaria (flatworms)										
F	*Dalyellia* sp.	---	---	1	---	---	---	---	---	---	---
F	Nematoda (roundworms)	---	---	---	1	---	---	---	---	---	---
	Amphipoda (scuds)										
I	*Pontoporeia affinis*	---	156	461	430	73	7	48	82	441	178
F	*Hydracarina* (water mites)	---	1	10	4	---	1	---	---	3	---
	Diptera (flies and midges)										
	Tendipedidae (pupae)[2]	---	3	4	---	---	4	1	---	---	6
F	*Hydrobaenus* sp.	---	---	1	---	12	3	---	---	---	---
F	*Calopsectra* sp.	---	1	6	7	7	3	1	---	---	1
F	*Tanytarsus* sp.	---	---	---	---	1	---	1	---	---	---
F	*Glyptotendipes* sp.	1	23	---	---	10	6	13	13	1	1
F	*Cryptachironomus* sp.	3	1	4	7	---	---	3	---	7	12
T	*Tendipes attenuatus*	6	66	135	49	3	72	43	84	53	33
	Total number of organisms/sq. ft.	10	249	652	514	143	121	110	219	530	227
	Total number of tolerant organisms/sq. ft.	6	64	146	58	40	97	43	124	66	76
	Total number of facultative organisms/sq. ft.	4	29	45	20	30	17	19	13	23	20
	Total number of intolerant organisms/sq. ft.	0	156	461	436	73	7	48	82	441	131
	Total number of species/sq. ft.	3	7	10	8	7	7	7	5	7	8
	Total number of tolerant species/sq. ft.	1	2	3	2	2	2	2	3	2	3
	Total number of facultative species/sq. ft.	2	4	6	5	4	4	4	1	4	3
	Total number of intolerant species/sq. ft.	0	1	1	1	1	1	1	1	1	2

---

[1] Tolerance status T = tolerant, F - facultative, I = intolerant.
[2] None of the Tendipedidae pupae are included in tabulation of animals present.

Table 2. Quantitative survey of benthic macroinvertebrates, Lake Michigan vicinity of E. I. duPont discharge near Montague, September 6, 1967

	Station Depth	1 20'	2 18'	3 19'	4 24'	5 47'	6 21'	7 20'	8 19'	9 17'	10 33'	11 11'	12 35'	13 11'	14 18'	15 17'	16 16'	17 15'	18 38'
	Distance offshore Distance along shore from discharge	1500', at discharge	1600', at discharge	1700', at discharge	2000', at discharge	6700', at discharge	1500' 100' N	1500' 200' N	1500' 500' N	1500' 1 mile N	1 mile 1 mile N	1500' 2 mile N	1 mile 2 mile N	1300', at discharge	1500' 100'	1500' 200' S	1500' 500' S	1500' 2½ mile S	1 mile 2½ mile S
Tolerance status[1]	and species	Number of animals per square foot																	
	Mollusca (snails and clams)																		
F	*Amnicola* sp	--	--	--	2	2	4	--	--	--	11	2	27	--	--	--	--	--	27
F	*Helisoma* sp	--	--	--	--	5	--	2	--	--	5	--	2	--	--	--	--	--	--
T	Sphaeriidae	--	--	--	2	2	--	--	--	--	7	--	2	--	--	--	--	--	--
T	Oligochaeta (aquatic earthworms)	4	2	5	255	9	17	43	73	--	74	5	57	--	--	12	34	12	2
	Cladocera (water fleas)																		
F	*Daphnia* sp	--	--	--	4	--	--	--	--	--	--	--	--	2	5	--	2	--	2
	Amphipoda (scuds)																		
I	*Pontoporeia affinis*	64	140	87	435	846	66	165	25	25	1060	48	1149	21	10	30	99	[illegible]	506
	Tricoptera (caddis flies)																		
I	*Oecetis* sp	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Diptera (flies and midges)																		
	Tendipedidae (pupae)[2]	--	11	2	5	--	7	4	9	9	--	9	--	2	7	11	5	7	6
F	*Prodiamesa bathyphila*	--	--	--	--	--	--	2	--	--	--	6	4	--	--	--	--	--	--
F	*Hydrobaenus nivoriunda*	--	--	--	7	2	--	--	--	--	5	--	--	--	--	--	--	--	--
F	*Hydrobaenus simulans*	--	--	--	--	--	218	7	--	--	--	--	--	--	4	3	--	--	--
F	*Hydrobaenus* sp	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Tendipedinae	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F	*Polypedilum illinoense*	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F	*Polypedilum* sp.	--	--	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F	*Glyptotendipes senilis*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--
F	*Glyptotendipes lobiferus*	--	--	--	4	--	--	--	--	--	--	74	--	--	--	--	--	--	--
F	*Glyptotendipes* sp	--	--	--	--	--	16	--	23	19	--	--	2	15	23	6	39	[illegible]	6
F	*Harnischia nais*	--	--	--	--	--	--	--	--	--	--	6	--	2	--	--	--	--	--
F	*Harnischia* sp. 1 (Roback	2	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
F	*Harnischia* sp	--	--	--	--	--	67	--	--	--	--	--	--	--	--	2	--	--	--
T	*Tendipes atroviridis*	--	12	--	--	--	--	--	--	--	--	6	--	60	--	--	2	--	--
T	*Tendipes ochreatus*	23	5	110	225	5	--	237	--	--	--	--	16	--	63	--	--	55	48
T	*Tendipes molestus*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
T	*Tendipes anthracinus*	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
T	*Tendipes attenuatus*	--	--	--	--	6	56	--	64	83	9	140	--	--	--	46	218	--	--
T	*Tendipes riparius*	--	--	--	--	--	--	--	6	--	--	28		--	9	--	--	--	--
	Number of organisms/square foot	98	247	209	943	875	500	456	269	167	1171	313	1276	122	133	117	[illegible]	87	596
	Total number of tolerant animals/sq. ft.	32	103	115	683	20	131	280	161	83	90	177	92	60	71	58		65	55
	Total number of facultative animals/ sq. ft.	2	4	7	24	9	303	11	103	59	21	88	35	19	52	29	41	11	33
	Total number of intolerant animals/ sq. ft.	64	140	87	437	846	66	165	25	25	1060	48	1149	23	10	30	99	11	506
	Total number of species/sq. ft.	5	7	4	10	8	7	6	6	3	7	9	9	5	6	7	7	4	8
	Total number of tolerant species/ sq. ft.	3	4	2	3	4	2	2	3	1	3	4	3	1	2	2	3	2	4
	Total number of facultative species/ sq. ft.	1	2	1	5	3	4	3	2	1	3	4	5	3	3	4	3	1	3
	Total number of intolerant species/ sq. ft.	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

[1] T = tolerant, F = facultative, I = intolerant.

[2] None of the Tendipedidae pupae are included in tabulation of animals present.

2808

Table 3. Lake Michigan surface water quality, vicinity of E. I. duPont discharge, September 10, 1957

Station	Location	Cdor	Depth	Temp. °C	DO mg/l	BOD mg/l	Cl mg/l	SO_4 mg/l	pH	NH_3 mg/l	Cu mg/l
10	White Lake channel		18'	13.5	10.6	1.1	5		8.2		
1	250' offshore, 1/2 mile S. of discharge		4'	9.3	10.8	2.5					
2	1,000' offshore, 1/2 mile S. of discharge	None	12'		10.6	1.6			8.2	0.0	0.0
3	2,000' offshore, 1/2 mile S. of discharge		21'	10.5	10.4	1.1					
--	duPont effluent					72	32	36	7.2	9.0	Trace
5	Immediately above discharge	Strong	18'	10	10.6	3.1	6	18	7.9	0.4	0.0
6	500' offshore at discharge	None	12'	10.5	10.7	1.4			8.3	0.0	0.0
7	800' offshore, 1/2 mile N. of discharge		10'	10.5	10.8	2.1					
4	2,000' offshore at discharge		24	10.5	10.6	1.1					
8	1,200' offshore, 1/2 mile N. of discharge	None	18'	10.5	10.8	1.8			8.0	0.0	
9	2,000' offshore, 1/2 mile N. of discharge		22'	10.0	10.8	1.8					

Table 4. Water quality of Lake Michigan, vicinity of duPont discharge, Montague, Michigan, September 6, 1967.

Station	Location	Odor	Depth	Temp. °C	DO mg/1	BOD mg/1	pH	Cl mg/1	Cu mg/1	NH_3 mg/1	CN mg/1	Sb mg/1	F mg/1
1-A	10' N.W. of discharge - 1,500' offshore	Strong chemical	20'	17	9.3	0.9	8.6	12	0.0	0.65	0.0	Neg.	0.2
1-B	10' N.W. of discharge - 1,500' offshore	Strong chemical	Surface	18	9.4	1.0	8.6	12	0.0	0.60	0.0	----	0.2
2	100' W. of discharge - 1,600' offshore	None	18'	17	---	---	8.6	5	---	0.0	---	----	---
3	200' W. of discharge - 1,700' offshore	None	19'	17	---	---	8.6	---	---	---	---	----	---
4	500' W. of discharge - 2,000' offshore	None	24'	17	---	---	---	4	---	0.0	---	----	---
5	1 mile W. of discharge - 6,780' offshore	None	47'	14	---	---	---	4	---	---	---	----	---
6	100' N. of discharge - 1,500' offshore	None	21'	17	---	---	8.6	4	---	0.0	---	----	---
7	200' N. of discharge - 1,500' offshore	None	20'	18	---	---	8.6	5	---	0.0	---	----	---
8	500' N. of discharge - 1,500' offshore	None	19'	17	---	---	---	4	---	---	---	----	---
9	1 mile N. of discharge - 1,500' offshore	None	17'	17	---	---	---	4	---	---	---	----	---
10	1 mile N. of discharge - 1 mile offshore	None	33'	17	---	---	---	4	---	---	---	----	---
11	2 miles N. of discharge - 1,500' offshore	None	11'	17	9.5	0.9	---	5	---	---	---	----	0.2
12	2 miles N. of discharge - 1 mile offshore	None	35'	17	9.8	1.2	---	4	---	---	---	----	0.2
13	200' E. of discharge - 1,300' offshore	None	11'	18	---	---	8.6	4	---	0.0	---	----	0.2
14	100' S. of discharge - 1,500' offshore	None	18'	18	---	---	8.6	8	---	0.0	---	----	---
15	200' S. of discharge - 1,500' offshore	None	17'	18	---	---	8.6	9	---	0.0	---	----	---
16	500' S. of discharge - 1,500' offshore	None	16'	18	---	---	---	5	---	---	---	----	0.2
17	1 mile S. of White Lake outlet - 1,500' offshore	None	16'	18	9.4	0.8	---	4	---	---	---	----	0.2
18	1 mile S. of White Lake outlet - 1 mile offshore	None	38'	18	9.8	1.2	---	4	---	---	---	----	0.2

Figure 3. Number of species of bottom animals per square foot and their tolerance status, duPont survey, Lake Michigan, 1957.

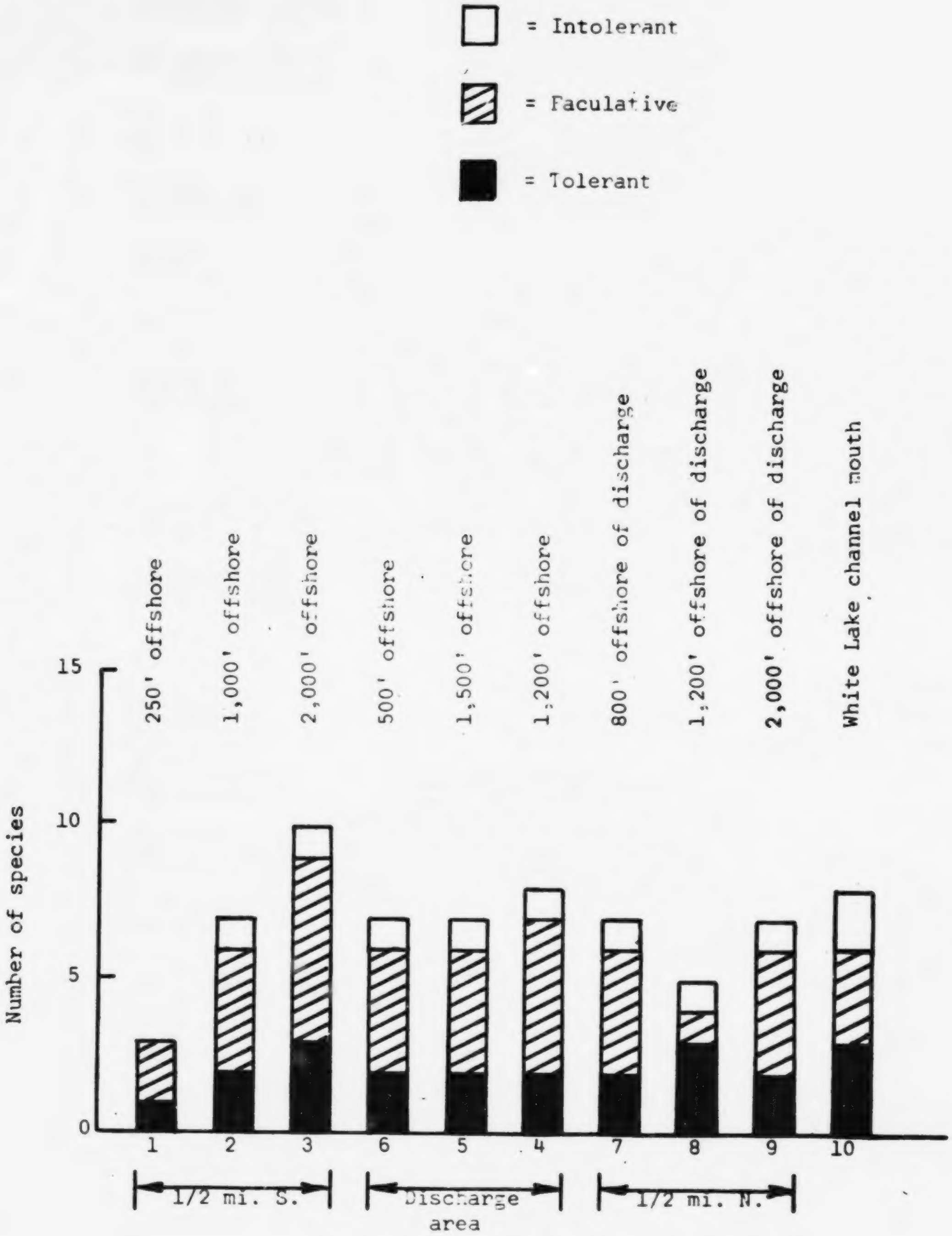


Figure 4. Number of species of bottom animals per square foot and their tolerance status, duPont survey, Lake Michigan, 1967.

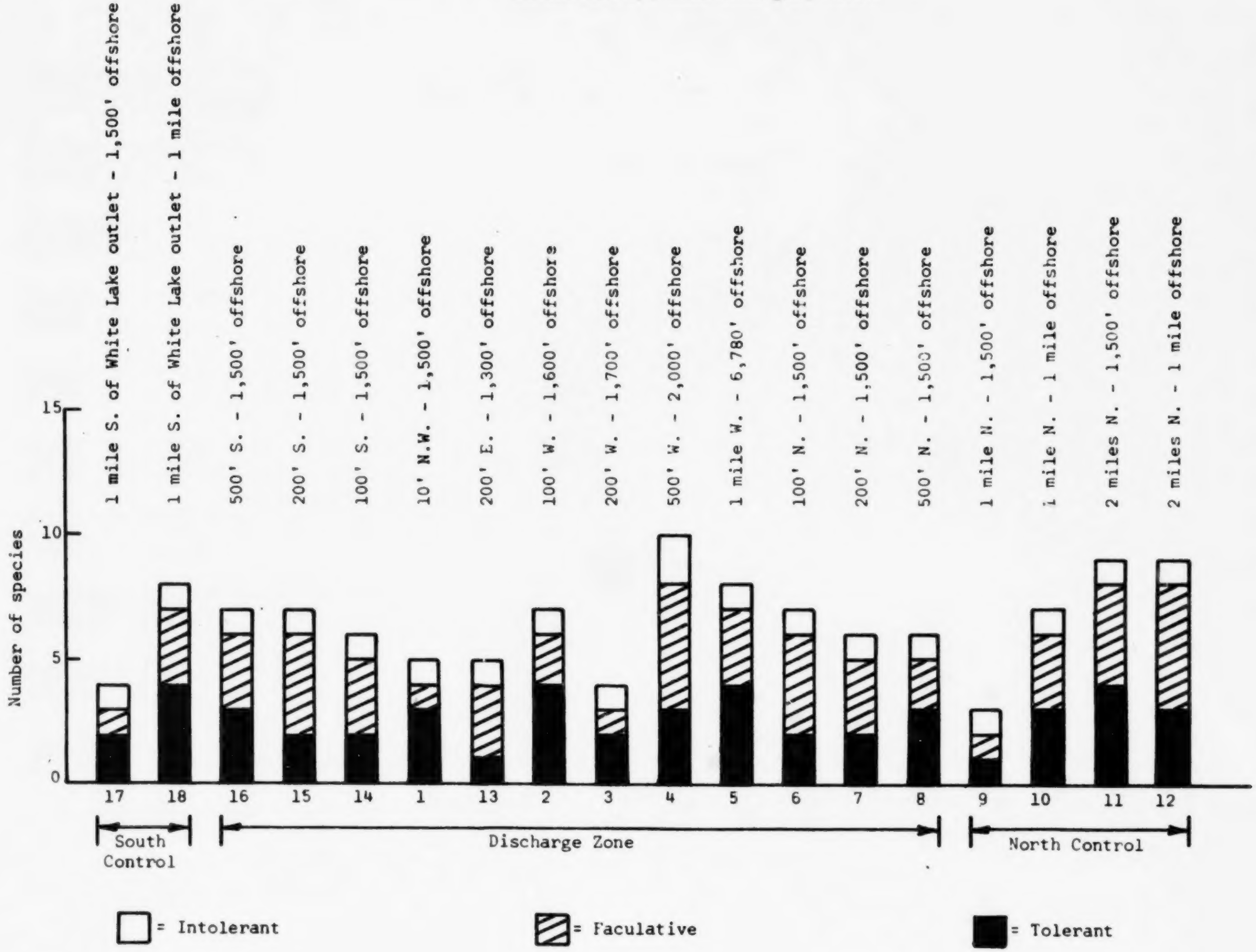


Figure 5. Relationship between water depth and tolerance status of benthic fauna. E. I. duPont survey, Lake Michigan, September 1957.

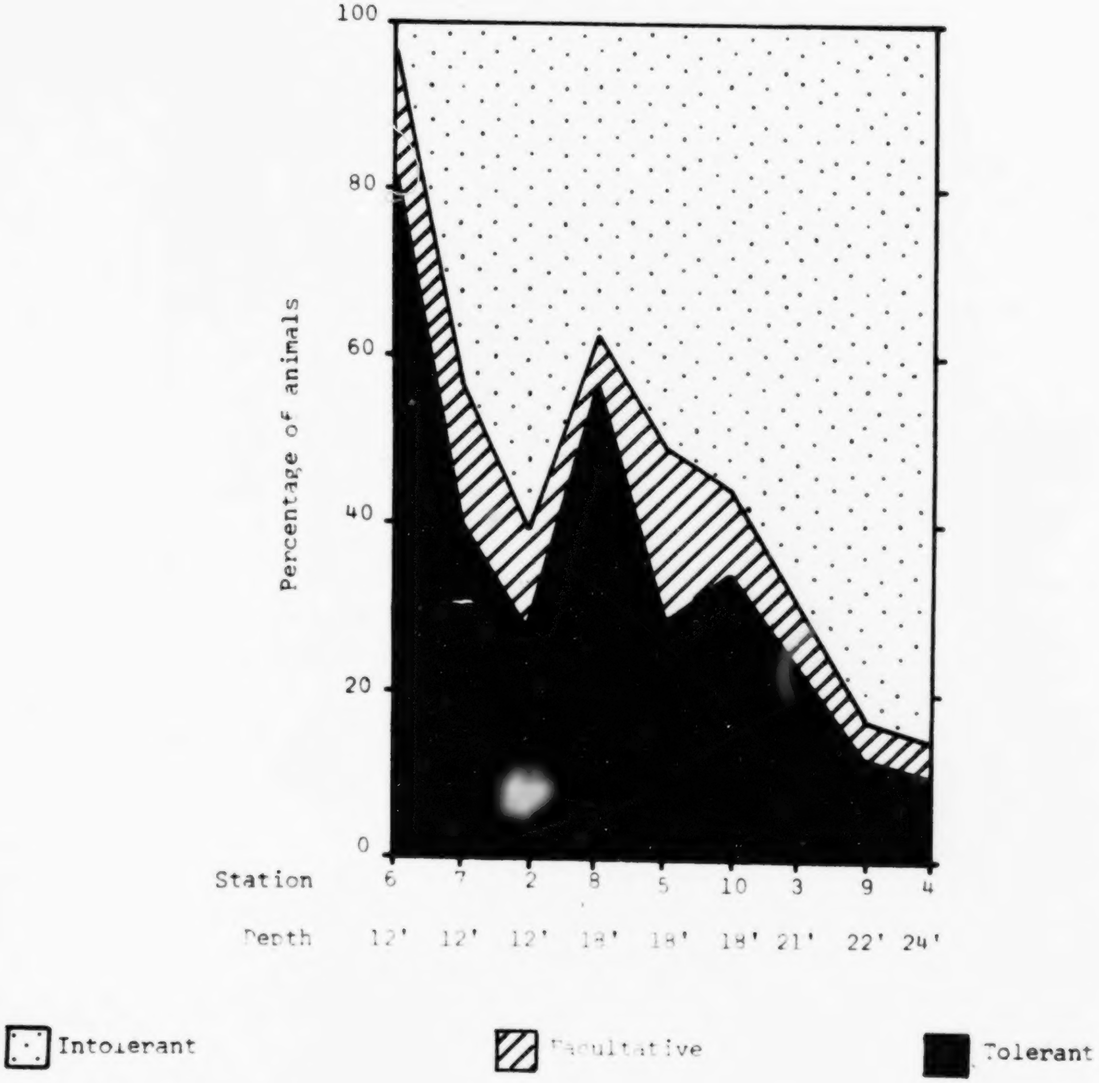
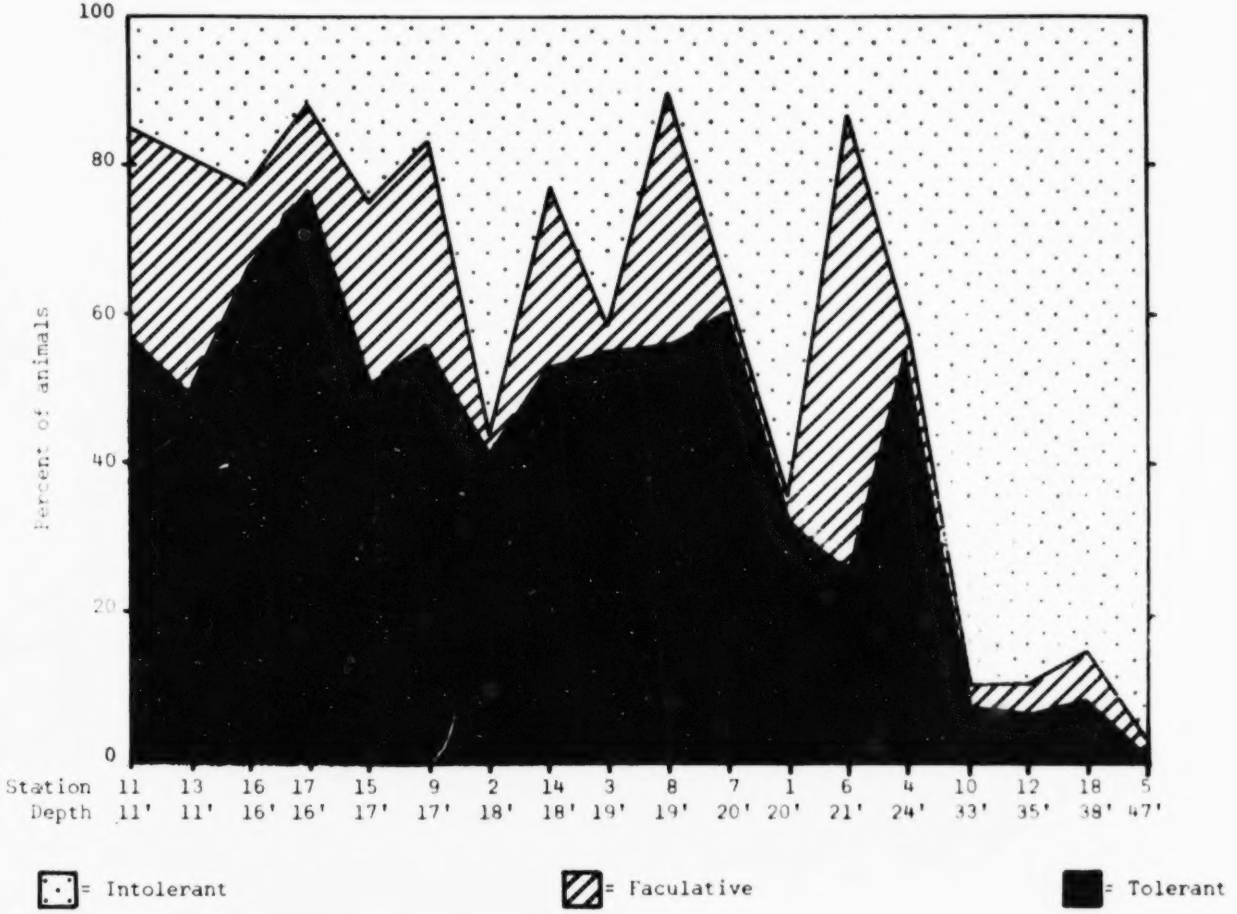


Figure 6. Relationship between water depth and tolerance status of benthic fauna. E. I. duPont survey, Lake Michigan, September 1967.



APPENDIX N

RECONNAISSANCE SURVEY
OF THE
DOW CHEMICAL COMPANY BRINE DISCHARGE
TO
LAKE MICHIGAN

Reconnaissance Survey of the Dow Chemical Company Brine Discharge to Lake Michigan near Big Sable Point, Mason County, Michigan

August 10, 1967

This reconnaissance survey was conducted to determine the general effect of the Dow discharge on the bottom fauna of Lake Michigan near Big Sable Point. High winds and increasingly rough water forced early termination of the study before the affected area could be clearly determined.

METHODS AND TECHNIQUES

Water samples were collected with a Kemmerer sampler, fixed in the field if necessary, and returned to Lansing for analyses (Table 1).

Separate samples were collected for conductivity measurements from which a nomograph was constructed for use with a remote-probe conductivity meter (Solu Bridge). By making several traverses perpendicular to shore the course of the brine discharge on this particular day was roughly determined.

Quantitative (areal) collections and some qualitative samples of the bottom-dwelling macroinvertebrates were made with a Ponar dredge. U.S. Standard #30 brass screens were used for sieving these samples. Samples were fixed with formalin and labeled as collected. Samples were washed and sorted and the organisms were identified and tabulated in the Lansing laboratory (Table 2). Animals were assigned a tolerance status according to published accounts and/or the past experience of the authors. Tolerance status refers to the animal's relative ability to withstand and/or respond to adverse environmental conditions. Individual tolerances are generally derived from an animal's reaction to organic wastes and attendant oxygen depletion or modification of bottom deposits.

Tolerance status may be generally defined as:

> Tolerant - organisms that can grow and develop within a wide range of environmental conditions. They are often found in water of poor quality. These species are generally insensitive to a variety of environmental stresses.
>
> Intolerant - organisms whose growth and development are dependent upon a narrow range of optimum environmental conditions. They are rarely found in areas of organic enrichment. They cannot adapt to adverse situations and are replaced by less sensitive organisms if the quality of their environment is degraded.

Facultative - organisms with the ability to survive over a wide range of conditions. They possess "medium" tolerance and often respond positively to moderate organic enrichment but cannot tolerate severe environmental stresses.

In addition to tolerance status, the diversity of animals present in a given benthic community is significant. In general, pollutional communities are characterized by very low species diversity, while normal undisturbed communities contain many different species.

Observations and Results

The Dow brine discharge to Lake Michigan is located approximately 2 1/2 miles north of the Big Sable Point lighthouse, Mason County, Michigan. Near the discharge the conductivity in micromhos of the bottom water ranged between 270,000 and 110,000 (78,000 and 30,000 mg/l Cl respectively) (Table 1). By trailing the conductivity probe it was determined that the brine flowed north in a band about 300 feet wide and 2 feet thick between the third and fourth sand bars which were approximately 900 feet offshore (Figure 1). Conductivity remained very high, 40,000 micromhos (8,000 mg/l Cl), as far as 1/2 mile northeast of the discharge. At this point the brine mass commenced to become significantly diluted and lost its identity. Traces could be detected 2 1/2 miles northeast of the discharge. High conductivity, 22,000 micromhos (3,700 mg/l Cl), was found 500 feet southwest of the discharge, but the concentration 900 feet southwest of the discharge was insignificant. The water mass immediately above the brine had low conductivity.

Dissolved oxygen of the bottom water in the area of very high conductivity was between 2.5 mg/l and 7.0 mg/l. The extent of this low oxygen area was not fully determined.

Quantitative samples of the benthic macroinvertebrate fauna were taken at 5 locations (Figure 2 and Table 2). An additional 10 samples were visually evaluated to roughly determine the extent of the effect of the brine on the bottom animals. Sixteen species were found altogether, 2 intolerant, 12 facultative, and 2 tolerant.

Bottom animals were virtually eliminated in the immediate vicinity of the discharge where only 1 animal was found. However, populations commenced recovering a short distance away and appeared near normal as close as 200 yards west of the discharge. Almost all of the qualitative samples had populations dominated by midges with a few snails, oligochaets and scuds.

Intolerant scuds were scarce in the 2 samples taken 900-1,000 feet offshore over 1 mile north and south of the discharge. Whether this is an effect of the brine following the trough between the sand bars will be evaluated on another survey.

Greater species diversity (13 species) was apparent at a depth of 60 feet 2 miles north of the discharge than it was at the same depth immediately off the discharge (4 species).

All bottom sediments were composed of fine, clean sand.

A second water quality and benthos survey has been scheduled for the summer of 1968. Our purpose will be to more clearly define the extent of chemical and biological effects surrounding the Dow discharge.

Field work by: D. James Seeburger, Aquatic Biologist
Michael E. Newton, Aquatic Biologist

Report by: D. James Seeburger
Water Quality Appraisal Unit
Michigan Water Resources Commission
January 27, 1968

Table 1. Water quality, Lake Michigan, in the vicinity of the Dow Chemical Company discharge, Big Sable Point, August 8, 1967.

Station	Location	Temperature °F	DO mg/1	Depth ft.	Cond. μ mhos	Cl mg/1	Na mg/1	Mg mg/1	Ca mg/1
A	At point of discharge	67	2.5	18	110,000	30,000	---	---	---
B	300 ft. NE of discharge	67	6.9	18	125,000	33,000	---	---	---
C	900 ft. NE of discharge	67	3.3	19	270,000	78,000	5,500	9,100	25,000
D	2 miles N of discharge 1 mile offshore	58	10.0	60	260	7	---	---	---
E	100 ft. west of discharge	67	9.0	20	290	10	---	---	---
F	2 1/2 miles S of discharge	67	8.6	12	520	82	---	---	---

Solu Bridge conductivity and mg/1 of Cl as determined from nomograph

Station	Location	Conductivity in μ mhos	Cl mg/1
G	Control - 3/4 mile offshore from Lincoln River outlet	220	6
H	At point of discharge	30,000	5,600
I	100 feet towards shore from discharge	20,000	3,400
J	200 feet towards shore from discharge	4,000	440
K	300 feet towards shore from discharge	420	25
L	100 feet NE from discharge	20,000	3,400
M	200 feet NE from discharge	7,000	850
N	300 feet NE from discharge	17,000	3,000
O	900 feet NE from discharge	40,000+	8,000+
P	1/2 mile NE from discharge	40,000	8,000
Q	1 1/2 miles NE from discharge	385	20
R	100 feet west from discharge	270	10
S	100 feet SW from discharge	40,000	8,000
T	200 feet SW from discharge	40,000	8,000
U	500 feet SW from discharge	22,000	3,700
V	900 feet SW from discharge	420	25
W	2 1/2 miles S of discharge 1/2 mile S of lighthouse	400	22

Table 2. Benthic macroinvertebrate organisms per square foot in the vicinity of the Dow Chemical Company discharge off Big Sable Point, Lake Michigan, August 8, 1967.

Station Sampler Depth	1 Ponar 16 feet	2 Ponar 18 feet	3 Ponar 60 feet	4 Ponar 60 feet	5 Ponar 12 feet
Tolerance status[1] and species	At discharge 900 feet offshore	1 1/2 miles north of discharge 900 feet offshore	2 miles north of discharge 1 mile offshore	1 mile offshore from discharge	1/2 mile south of lighthouse 1,000 feet offshor
Mollusca (clams, snails)					
I Lymnaeidae (*Stagnicola*) sp.			1		
F *Valvata* sp.			4		
T *Sphaeriidae*			16		
T Oligochaeta (aquatic earthworms)		2	29	4	
Coelenterata (hydroids)					
F *Hydra* sp.			2		
Cladocera (water fleas)					
F *Daphnia* sp.		1	1		
Amphipoda (scuds)					
I *Pontoporeia affinis*		1	578	103	6
Coleoptera (beetles)					
Elmidae					
F *Dubiraphia vittata*	1				
Diptera (flies and midges)					
F Tendipedidae (pupae)[2]		6	2	1	2
F *Prodiamesa* (M) *bathyphila*		1	5		
F *Diamesa* (P) *campestris*					
F *Diamesa* (P) *fulva*		33	4	4	25
F *Calopsectra* sp.			8		
F *Microtendipes tarsalis*			1		
F *Pseudochironomus* sp.			5		
F *Tendipes* (*T*) *staegeri*		57	7	8	12
Total no. of organisms/sq. ft.	1	95	661	119	43
Total no. of tolerant organisms/sq. ft.	0	2	45	4	0
Total no. of facultative organisms/sq. ft.	1	92	37	12	37
Total no. of intolerant organisms/sq. ft.	0	1	579	103	6
Total no. of species/sq. ft.	1	6	13	4	3
Total no. of tolerant species/ sq. ft.	0	1	2	1	0
Total no. of facultative species/sq. ft.	1	4	9	2	2
Total no. of intolerant species/sq. ft.	0	1	2	1	1

[1] T = Tolerant, F = Facultative, I - Intolerant

[2] None of the Tendipedidae pupae are included in tabulation of animals present.

Figure 1 . Water quality sampling locations in the vicinity of the Dow Chemical Company discharge, Big Sable Point, Lake Michigan, August 8, 1967.

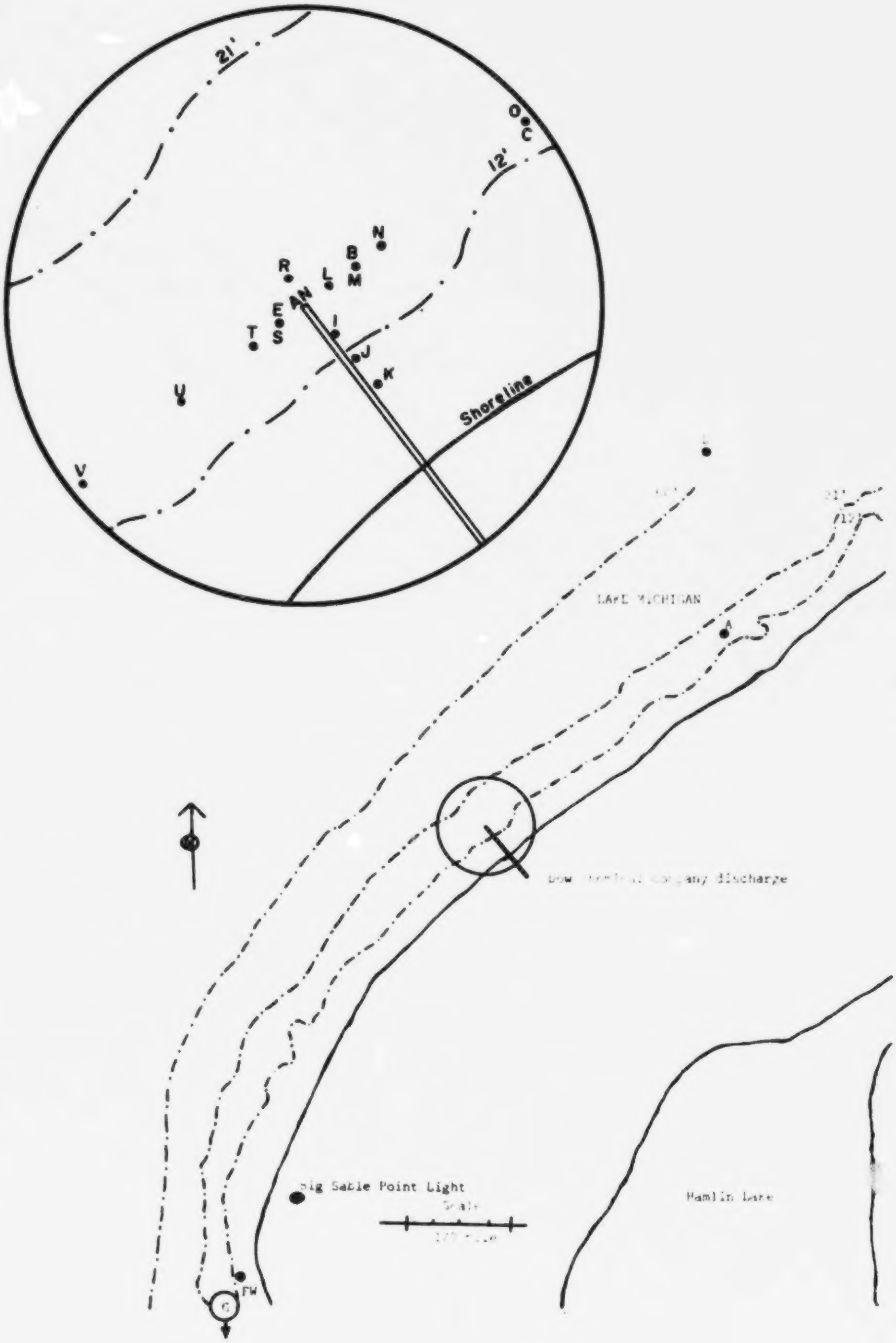
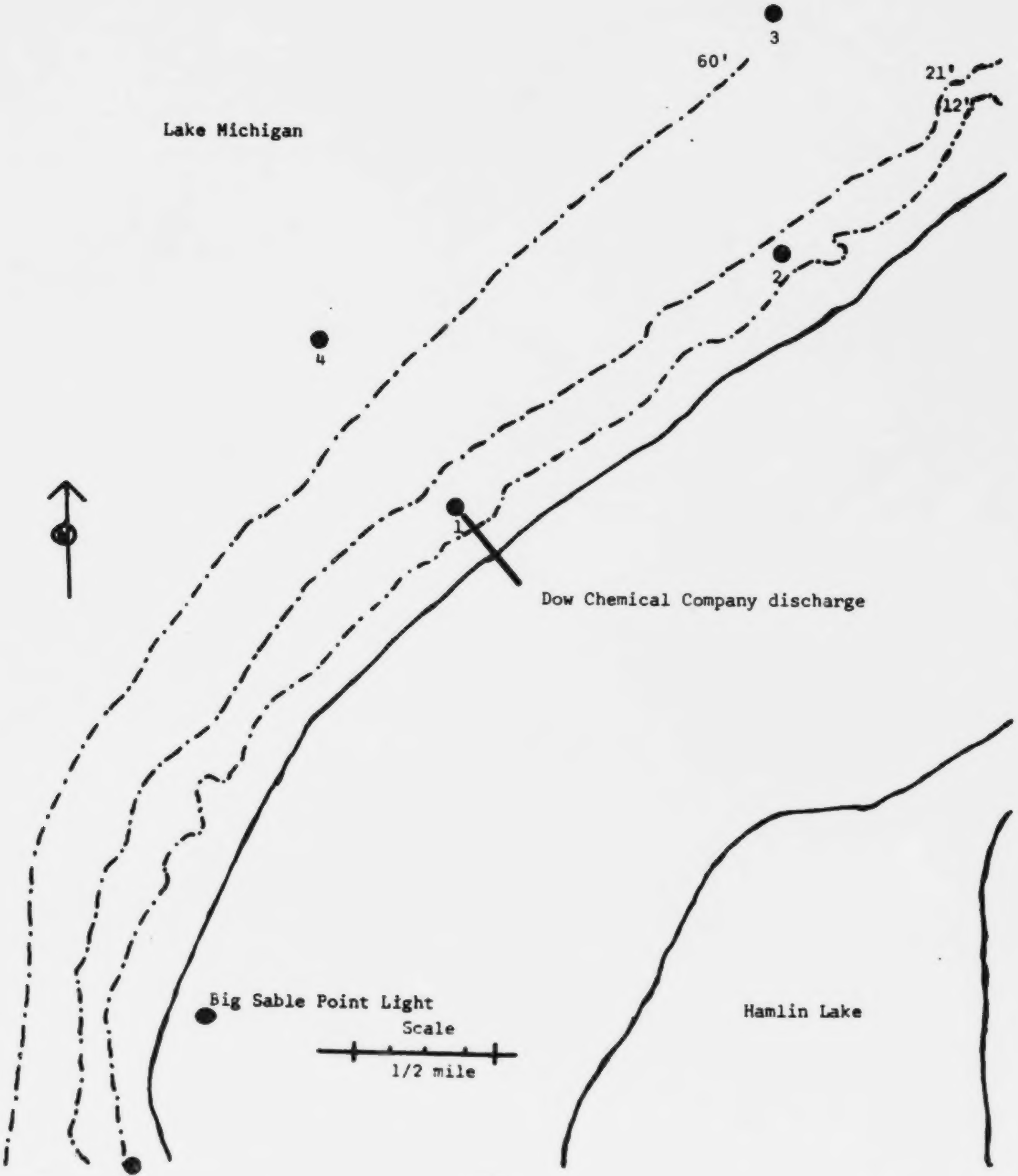

21'
O
C
12'
N
B
M
R
L
AN
E
I
T
S
J
K
U
V
Shoreline
21'
12'
LAKE MICHIGAN
A
Dow Chemical Company discharge
Big Sable Point Light
Scale
1/2 mile
Hamlin Lake
FW
G

Figure 2. Benthic macroinvertebrate sampling stations in the vicinity of the Dow Chemical Company discharge off Big Sable Point, Lake Michigan, August 8, 1967.


3
60'
21'
12'
Lake Michigan
2
4
1
Dow Chemical Company discharge
Big Sable Point Light
Scale
1/2 mile
Hamlin Lake
5

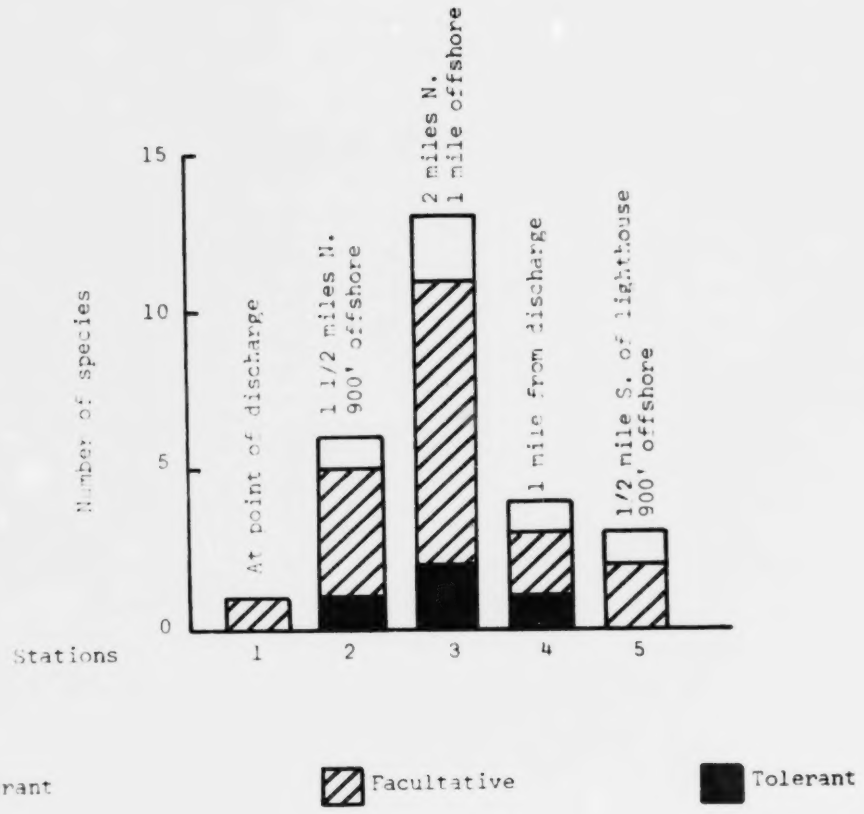


Figure 3. Benthic macroinvertebrate species per square foot and their tolerance status, reconnaissance survey vicinity of the Dow Chemical Company discharge to Lake Michigan, Big Sable Point, August 8, 1967.

APPENDIX O

BENTHIC MACROINVERTEBRATE STUDY

LAKE MICHIGAN AT MANISTEE IN THE VICINITY
OF
PACKAGING CORPORATION OF AMERICA'S
WASTE DISPOSAL PIPELINE

WATER RESOURCES COMMISSION

Benthic Macroinvertebrate Study

Lake Michigan at Manistee in the Vicinity of Packaging Corporation of America's Waste Disposal Pipeline

September 1, 1967

This survey was conducted to ascertain the effect that Packaging Corporation of America's (PCA) waste discharge to Lake Michigan has on the benthic macroinvertebrate population in the vicinity of the discharge. PCA's plant at Filer City is located on the south end of Manistee Lake in Manistee County, Michigan and produces paper products from pulp wood. Their waste disposal pipeline to Lake Michigan was originally designed to remove the majority of their waste load from the south end of Manistee Lake. Manistee Lake and its tributaries have long supported one of the largest steelhead runs in Michigan's Lower Peninsula. The primary purpose of the waste diversion to Lake Michigan was to guard against unlawful pollution and protect the water quality in Manistee Lake, particularly during times of fish migrations. The original use of Lake Michigan for waste disposal purposes was covered by an Order of the Michigan Water Resources Commission adopted June 28, 1956 and amended September 24, 1959 following statements of new and increased use by the American Box Board Company, which as of July 31, 1959 merged into PCA.

Members of the Water Resources Commission staff have conducted several studies of waste quality and biological conditions in the vicinity of the Lake Michigan outfall throughout the years. Conditions found have generally been satisfactory. One aspect that was periodically questionable was the lowering of aesthetic and recreational values of Lake Michigan waters adjacent to the discharge. Complaints of undesirable odors and unnatural colors increased as public contact with these waters increased. During December 1963 the Water Resources Commission staff demonstrated that PCA was not conforming to the original restrictions and concluded that the undesirable odors and colors in Lake Michigan as a result of the PCA discharge were detrimental to uses being made of the lake.

PCA was requested to take corrective action. The company proposed to increase the specific gravity of its waste through the addition of brines which were being discharged to Manistee Lake by a neighboring company. Studies by PCA indicated this would eliminate the color streaking and the movement of the wastes toward the shoreline. The WRC thought the PCA proposal worthy of a trial. On August 15, 1964 a brine pumping station was completed and through its operation the specific gravity of the waste being discharged to Lake Michigan was increased. On September 21 and 22, 1964 an inspection of the pipeline outfall area and Lake Michigan beaches disclosed no detectable odors or visible discoloration.

Background benthic macroinvertebrate studies in the vicinity of the discharge had been made on July 15-17, 1957 (before the waste pipeline became operative), September 11, 1958 and September 14, 1962 (before the brine pumping station was operative). These surveys demonstrated that the bottom animal population in the vicinity of the discharge was indicative of a clean water environment. No detrimental effects could be ascertained when the 1958 and 1962 conditions were compared to the background bottom animal population. During the summer of 1966 a question was raised regarding the effects that the addition of brine and the resulting change in the chemical and physical properties of the PCA waste might have on the invertebrate population in the vicinity of the Lake Michigan discharge.

METHODS

On September 1, 1967 chemical and biological samples were collected at 16 locations along the Lake Michigan shore (Figure 1 and Table 1).

Table 1

Sampling locations, chemical and benthic macroinvertebrate study, Lake Michigan, vicinity of the PCA pipeline outlet, Manistee County, September 1, 1967.

Station No.	Depth in feet	Distance from shore in feet	Approximate direction and distance from the PCA discharge
1	35	4,000	4 miles NNE
2	31	4,000	3 miles NNE
3	20	1,000	3 miles NNE
4	31	8,000	1 mile NNW
5	33	4,000	1 mile N
6	14	1,000	1 mile NNE
7	34	8,000	7,000 feet WNW
8	31	4,000	3,000 feet WNW
9	16	1,000	PCA discharge area
10	14	500	500 feet ESE
11	37	8,000	1 mile W
12	31	4,000	1 mile SW
13	25	1,000	1 mile SSW
14	28	4,000	3 miles SSW
15	16	1,000	3 miles SSW
16	25	4,000	4 miles SSW

Benthos samples were collected with a Ponar dredge at all stations. Only completely closed dredge hauls were evaluated. One dredge haul was evaluated from each of the 16 stations. Samples were screened with a U.S. Standard Number 30 soil seive. A complete species list of benthic macroinvertebrates together with their tolerance status is presented in Table 2. Tolerance status is derived from an animal's reaction to organic wastes and attendant oxygen depletion or modification of bottom deposits. Tolerance status may be generally defined as:

Tolerant - organisms that can grow and develop within a wide range of environmental conditions. They are often found in water of poor quality. These species are generally insensitive to a variety of environmental stresses.

Intolerant - organisms whose growth and development are dependent upon a narrow range of optimum environmental conditions. They are rarely found in areas of organic enrichment. They cannot adapt to adverse situations and are replaced by less sensitive organisms if the quality of their environment is degraded.

Facultative - organisms with the ability to survive over a wide range of conditions. They possess "medium" tolerance and often respond positively to moderate organic enrichment but cannot tolerate severe environmental stresses.

In addition to tolerance status, the diversity of animals present in a given benthic community is significant. In general, pollutional communities are characterized by very low species diversity, while normal undisturbed communities contain many different species.

Conductivity and temperature readings were taken near the surface and near bottom at each sampling station with a Solu Bridge. The conductivity readings were converted to mg/l of chlorides with a nomogram calibrated for chlorides in Lake Michigan at Manistee. Transparency was measured with a standard Secchi disc at all sampling stations. Temperatures, transparency, conductivity, and chloride concentrations are presented in Table 3.

OBSERVATIONS

The bottom material at the majority of stations was clean sand with the exception of stations 8 and 9 which had a thin layer of light flocculent material over clean sand. The extent of this light deposit was limited. No unnatural odors were observed throughout the survey. An inspection of the Lake Michigan beaches both to the north and south of the pipeline indicated very clean waters with no visual discoloration or detectable debris along the shore.

For the evaluation of this benthic survey the stations have been grouped into 5 zones (Figures 2 and 3) with zones N-1 and N-2 north of the discharge zone and zones S-1 and S-2 south of the discharge zone.

Zone N-2 (stations 1, 2 and 3) extends from 2 to 5 miles north of the discharge. In this zone 10 species of bottom-associated organisms were sampled. Four of these were tolerant, 5 facultative, and 1 intolerant. The intolerant species was the scud Pontoporeia affinis. Chloride content of the water in this zone ranged between 22 and 27 mg/l and the Secchi transparency was between 9 and 10.5 feet.

Zone N-1 (stations 4, 5 and 6) extends from 1/2 to 2 miles north of the discharge. In this zone 12 species of bottom-associated organisms were sampled. Two of these were tolerant, 9 facultative, and 1 intolerant. Again the intolerant species was Pontoporeia affinis. The chloride content of the water in this zone ranged between 15 and 19 mg/l and the Secchi transparency was 12 feet throughout.

The discharge zone (stations 7, 8, 9 and 10) extends from 1/2 mile north to 1/2 mile south of the PCA discharge. Station 9 is in the immediate vicinity of the discharge. In the discharge zone 7 species of bottom-associated organisms were sampled. Four of these were tolerant and 3 faculative. No intolerant animals were collected from this zone. The chloride content of the water ranged between 15 mg/l at the surface to 248 mg/l near the bottom in the immediate vicinity of the discharge. The Secchi transparency readings ranged between 9 and 13 feet throughout the zone, with the less transparent water occurring nearest the shore.

Zone S-1 (stations 11, 12 and 13) extends from 1/2 mile to 2 miles south of the discharge. In this zone 17 species of bottom-associated organisms were found. Three of these were tolerant, 13 facultative and 1 intolerant. The single intolerant species was once again Pontoporeia affinis. The chloride content of the water ranged between 15 and 17 mg/l and the Secchi transparency was between 6.5 and 13 feet. Again the less transparent water occurred nearest the shore. This phenomenon was apparently associated with wave action in the shallower water rather than any discoloration from the discharge. Wind was from the WSW at more than 10 mph.

Zone S-2 (stations 14, 15 and 16) extends from 2 to 5 miles south of the discharge. In this zone 11 species of bottom-associated organisms were found. Three of these were tolerant, 7 facultative and 1 intolerant. The single intolerant form was again Pontoporeia affinis the same species collected from zones N-2, N-1 and S-1. The chloride content of the water ranged between 10 and 17 mg/l and the Secchi transparency was between 6.5 and 7 feet.

SUMMARIZATION OF RESULTS

From the physical, chemical and biological data obtained from this survey the following conclusions may be reached:

1. In the immediate vicinity of the PCA discharge a thin layer of a soft white material forms a deposit of limited area. No trace of this material could be found in the zones adjacent to the discharge. Apparently wave action or currents prevent the accumulation of greater amounts of this material.

2. Water in the immediate vicinity of the PCA discharge at a depth of 16 feet was saturated with oxygen.

3. Surface chloride concentrations in Lake Michigan in the vicinity of the PCA discharge ranged between 10 and 27 mg/l. The chloride concentration near bottom in this area was 248 mg/l. Chloride readings taken near bottom 500 feet offshore at the discharge (station 10) showed that the chlorides had dropped to 41 mg/l while readings taken near bottom 4,000 feet (station 8) and 8,000 feet (station 7) offshore at the discharge showed concentrations of 130 mg/l. This demonstrates that the majority of the PCA waste was moving away from shore on this date. Chloride measurements made near bottom 1 mile north and 1 mile south of the PCA discharge showed no significant concentrations of chlorides.

4. A series of water temperatures taken in the vicinity of the PCA Lake Michigan discharge showed virtually no differences between temperatures found in the adjacent zones.

5. Secchi transparency readings taken in the vicinity of the PCA Lake Michigan discharge showed no decrease in transparency of the surface waters. Suspended solids from a water sample taken near the bottom in the immediate vicinity of the discharge were only 7 mg/l.

6. Benthos samples collected from 2 zones extending from 1/2-5 miles north of the PCA Lake Michigan waste discharge and from 2 zones extending from 1/2-5 miles south of the discharge were representative of bottom animal populations indicative of a clean water environment. Samples collected from the discharge zone itself did not contain intolerant scuds found in the other zones, although significant numbers of facultative and tolerant forms were collected. The species diversity in this zone was lower than that of the adjacent zones.

CONCLUSION

Near a waste discharge of this nature we may anticipate that the bottom fauna will be changed in the prescribed mixing or discharge zone. At present we can show no adverse effects on the benthic macroinvertebrate populations sampled in the zones adjacent to the PCA Lake Michigan dsicharge when these populations are compared to bottom animal populations that existed in 1957 prior to the discharge of waste at this point.

Field work by:	Michael E. Newton, Aquatic Biologist D. James Seeburger, Aquatic Biologist
Laboratory work by:	Michael E. Newton D. James Seeburger Blanchard Mills, Water Pollution Investigator
Report by:	Michael E. Newton Water Quality Appraisal Unit Michigan Water Resources Commission January 9, 1968

2830

Figure 1. Location of benthic macroinvertebrate sampling stations, Lake Michigan at Manistee in the vicinity of the Packaging Corporation of America waste disposal pipeline, September 1, 1967, showing depths from U.S. Lake Survey chart. (● = sampling station) (✱ = sampling station and pipeline discharge point)

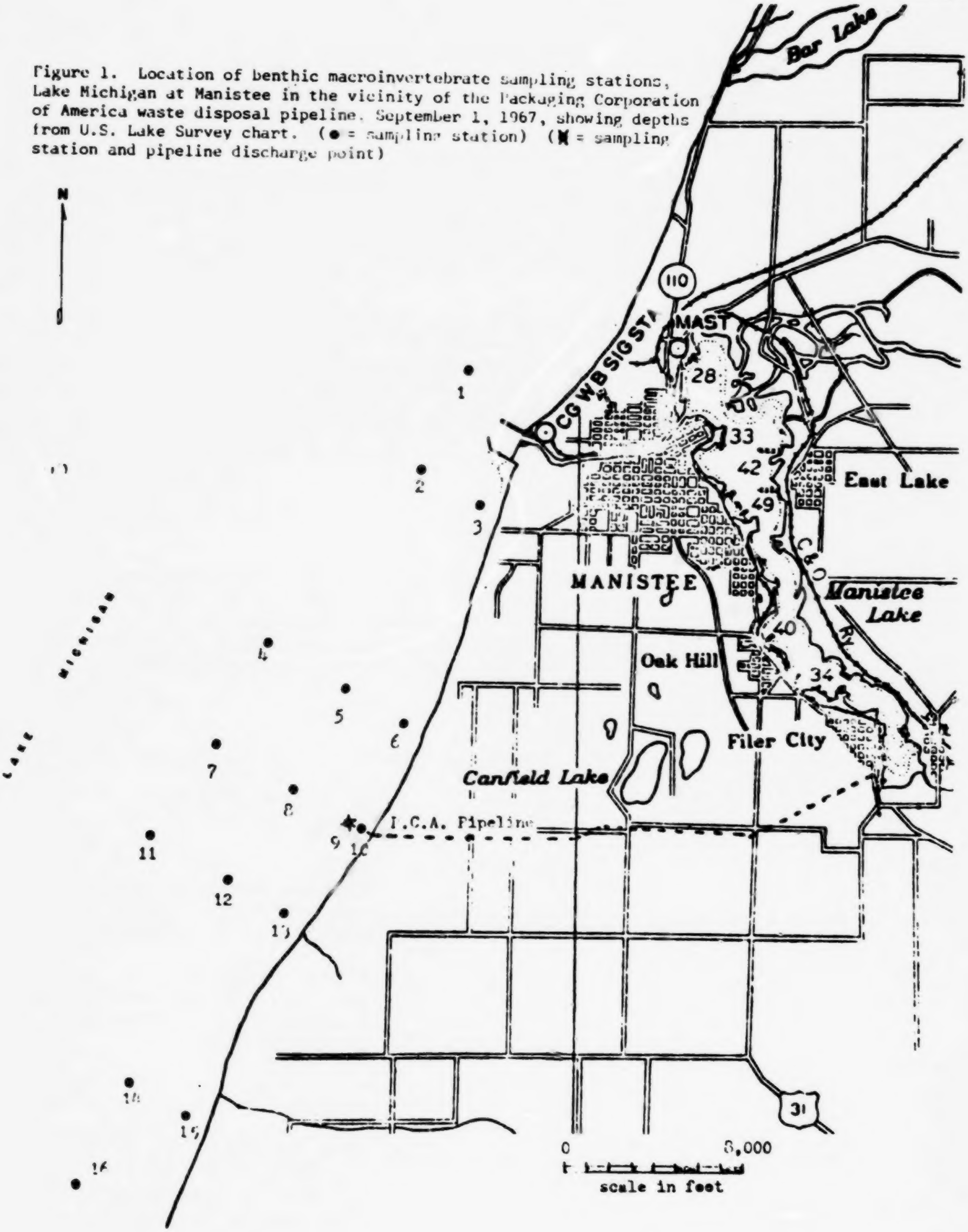

N
Bar Lake
110
CG WB SIG STA
MAST
28
33
42
49
East Lake
C&O Ry
MANISTEE
Manistee Lake
40
34
Oak Hill
Filer City
Canfield Lake
P.C.A. Pipeline
LAKE MICHIGAN
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
31
0
8,000
scale in feet

Table 2. Results of a survey of the bottom-dwelling macroinvertebrate population, Lake Michigan at Manistee in the vicinity of the Packaging Corporation of America waste disposal pipeline: September 1, 1967. (I = intolerant to pollution, F = facultative to pollution and T = tolerant to pollution).

Zone			N-2			N-1			Discharge				S-1			S-2	
Station		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Distance from shore in feet		4,000	4,000	1,000	8,000	4,000	1,000	8,000	4,000	1,000	500	8,000	4,000	1,000	4,000	1,000	4,000
Depth in feet		35	31	20	31	33	14	34	31	16	14	37	31	25	28	16	25
Oligochaeta (aquatic earthworms)																	
Tubificidae	T	4		120		104		23	16			39			2	2	4
Chaetogaster sp.	F					2						2					
Stylaria sp.	F					7						11	2		5		
Amphipoda (scuds)																	
Pontoporeia affinis	I	2		14		37	11					16		2	2		11
Hydracarina (water mites)	F			2													
Tendipedinae (true midges)																	
Pelopiinae																	
Diamesa (P) *bathyphila*	F					7		2	2			5			2		
Diamesa (P) *campestris*	F											2					
Hydrobaeninae																	
Psectrocladius elatus	F					7						4	9		2		
Psectrocladius sp.	F		2														
Tendipedinae (pupae)	F		4		4	9		2				4	2		2		5
Cryptochironomus sp. 3	F			9			4			4	2		5			7	12
Cryptochironomus sp. 9(Lipina)	F												4	20	4	28	11
Cryptochironomus rolli	F											2					
Cryptochironomus nr. *camptolabis*	F											2					
Cryptochironomus unk.	F						2										
Calopsectra sp.	F			5													
Tanytarsus (T) sp. 2	F											4					
Tanytarsus (Stictochironomus) sp. 1	F				2							4				2	
Tendipes attenuatus	T								7	4							2
Tendipes plumosus	T	9															
Tendipes riparius	T			122		30	39	11	50	21	5	9	50	2	23	21	14
Tendipes (L) *modestus*	T								2								
Tendipes (C) *atroviridis*	T												9				
Microtendipes tarsalis	F												2				
Harnischia nr. *nais*	F					2											
Glyptotendipes lobiferus	F						18										
Pelecypoda																	
Sphaeriidae (fingernail clams)	T			4													
Number of species/sq. ft.		3	2	7	2	9	5	4	5	3	2	13	8	3	8	5	7
Number of individuals/sq. ft.		15	6	276	6	205	74	38	77	29	7	104	83	24	42	60	59
Number of intolerant species		1	0	1	0	1	1	0	0	0	0	1	0	1	1	0	1
Number of faculative species		0	2	3	2	6	3	2	1	1	1	10	6	1	5	3	3
Number of tolerant species		2	0	3	0	2	1	2	4	2	1	2	2	1	2	2	3

Table 3. Tabulation of chemical and physical data from Lake Michigan in the vicinity of the Packaging Corporation of America pipeline outlet, Manistee County.

September 1, 1967

Sampling station		Depth	Temp. °F	Secchi transparency	mμ conductivity	mg/l chlorides
1	Surface	---	57	9'	250	22
1	Bottom	35 ft.	46	---	250	22
2	Surface	---	57	10'	260	24
2	Bottom	31 ft.	48	---	260	24
3	Surface	---	56	10.5'	270	27
3	Bottom	20 ft.	51	---	270	27
4	Surface	---	52	12'	230	17
4	Bottom	31 ft.	46	---	230	17
5	Surface	---	52	12'	220	15
5	Bottom	33 ft.	46	---	230	17
6	Surface	---	46	12'	220	15
6	Bottom	14 ft.	44	---	240	19
7	Surface	---	52	13'	220	15
7	Bottom	34 ft.	46	---	700	130
8	Surface	---	48	9.5'	240	19
8	Bottom	31 ft.	44	---	700	130
9	Surface	---	46	9'	220	15
*9	Bottom	16 ft.	44	---	1,200	248
10	Surface	---	46	12.5'	220	15
10	Bottom	14 ft.	42	---	330	41
11	Surface	---	50	13'	220	15
11	Bottom	37 ft.	44	---	230	17
12	Surface	---	48	9'	230	17
12	Bottom	31 ft.	45	---	230	17
13	Surface	---	50	6.5'	220	15
13	Bottom	25 ft.	48	---	230	17
14	Surface	---	50	7'	220	15
14	Bottom	28 ft.	43	---	220	15
15	Surface	---	48	6.5'	200	10
15	Bottom	16 ft.	45	---	220	15
16	Surface	---	50	7'	220	15
16	Bottom	25 ft.	43	---	230	17

*Water collected near bottom with a Kemmerer water bottle at Station 9-B (the Packaging Corporation of America Lake Michigan discharge) contained 7 mg/l suspended solids and 12.5 mg/l dissolved oxygen.

Figure 2. Location of benthic macroinvertebrate sampling stations, Lake Michigan at Manistee in the vicinity of the Packaging Corporation of America waste disposal pipeline, September 1, 1967, illustrating established sampling zones. (● = sampling station) (✱ = sampling station and pipeline discharge point)

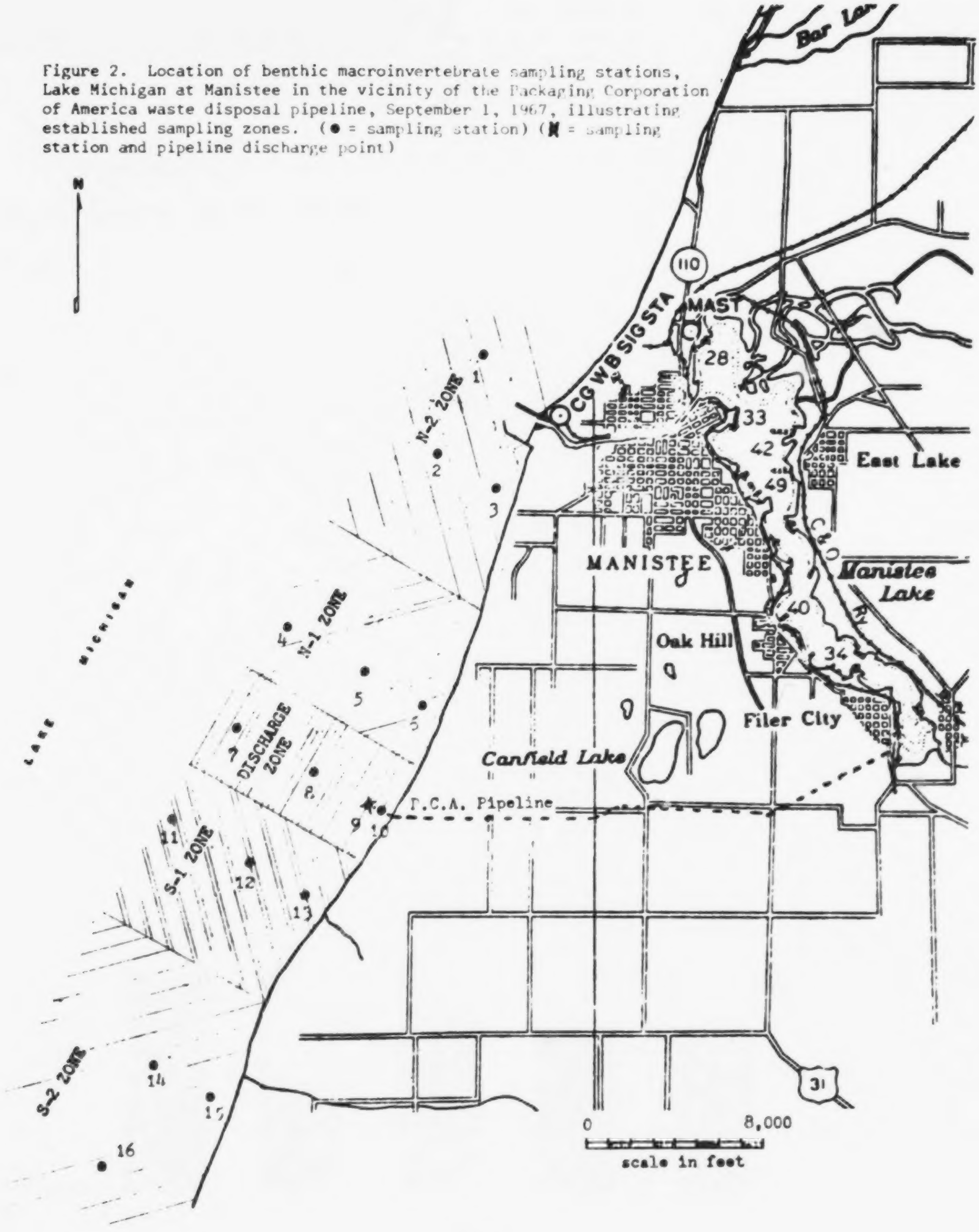
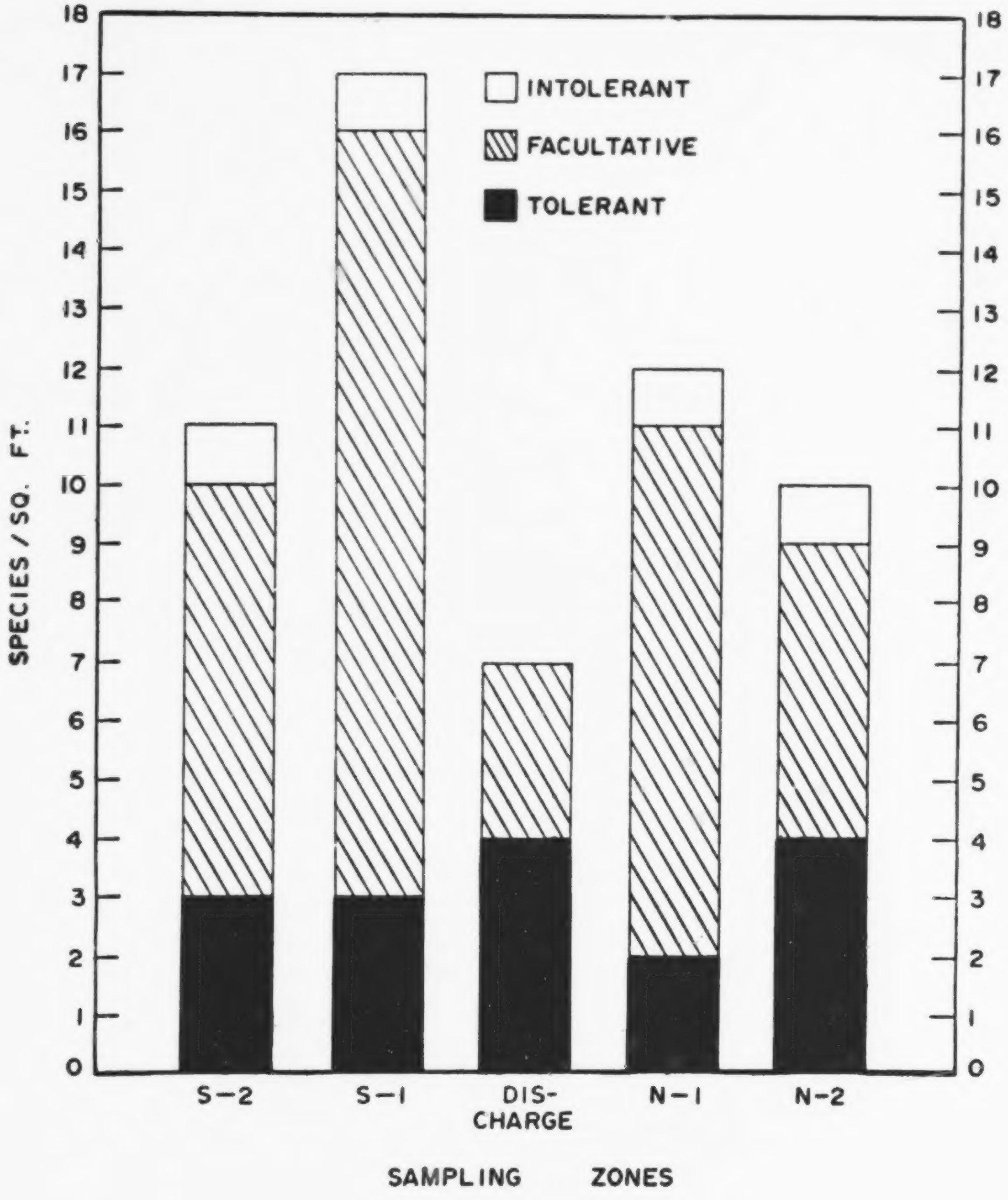

N
Bar Lake
110
CG WB SIG STA
MAST
28
33
42
49
East Lake
C&O Ry
MANISTEE
Manistee Lake
40
34
Oak Hill
Filer City
Canfield Lake
LAKE MICHIGAN
N-2 ZONE
N-1 ZONE
DISCHARGE ZONE
S-1 ZONE
S-2 ZONE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
P.C.A. Pipeline
31
0
8,000
scale in feet

Figure 3. Number of bottom-dwelling macroinvertebrate species and their tolerance status from five sampling zones, Lake Michigan at Manistee in the vicinity of the Packaging Corporation of America waste disposal pipeline, September 1, 1967.



2835

APPENDIX P

RADIOLOGICAL INVESTIGATIONS OF AQUATIC BIOTA
IN THE VICINITY OF THE
BIG ROCK POINT NUCLEAR REACTOR

MICHIGAN WATER RESOURCES COMMISSION

Radiological Investigations of Aquatic Biota in the Vicinity of the Big Rock Point Nuclear Reactor

1960-1967

Beginning in 1960 collections of aquatic plants and animals for radiological analysis have been made twice a year in the vicinity of Consumers Power Company's Big Rock Point Nuclear Reactor. Data collected prior to September 1962 when the reactor went critical are indicative of the radiation levels to be expected due to fallout and natural background sources.

The Big Rock Point Reactor site is located on the south shore of Little Traverse Bay, Lake Michigan, in Charlevoix County, Michigan. The immediate and general area is heavily wooded and sparsely populated. The shore line is rocky, barren, and exposed to wind and wave action. Stations for the collection of aquatic biota have been established at Mount McSauba Point, Big Rock Point, and Nine Mile Point (Figure 1). Mount McSauba Point is approximately three miles southwest of the reactor and Nine Mile Point is approximately three miles east of the reactor. From Mount McSauba Point to Nine Mile Point the six foot depth contour occurs between fifty and three hundred yards offshore. Generally the depth increases rapidly beyond this contour to depths greater than one hundred feet a mile from shore. Bottom type of the inshore area is uniformly rocky with underlying gravel and some sand.

The direction of current flow is important at this location due to the proximity of the water intakes at Charlevoix and Petoskey. Studies of Lake Michigan surface currents have shown that the major surface current structure of Lake Michigan can change greatly over a three week period. In spite of this instability, a northward current paralleling the east shore of the upper half of Lake Michigan is usual. These studies suggest that when westerly winds are blowing, a clockwise current circulates in Little Traverse Bay, resulting in a westward moving current past the reactor site towards Petoskey. Wind direction data from the U.S. Coast Guard Lifeboat Station at Charlevoix indicate that the westward moving shore current would be the normal one.

Monthly water samples have been collected and analyzed from six locations in the Big Rock vicinity (Figure 1). The annual monthly average radioactivity counts of these samples have been plotted together for comparative purposes in Figure 2 along with similar averages from six samples taken considerable distances from Charlevoix. Three of the latter were from Lake Michigan and three from large rivers. This comparison indicates that the radioactivity concentrations found in the Charlevoix area are similar to those found at other locations in Michigan.

Plankton samples were secured with a standard number 20 silk bolting cloth net towed through the very clear water. Collections of other aquatic organisms were made near shore in water less than three feet deep. Gross alpha and beta concentrations of these organisms are reported in microcuries per gram x 10^{-7} on an oven dry basis.

The radioactivity of plankton collected near Big Rock Point has not varied siginificantly from the counts of plankton at the two stations three miles distant (Figure 3). Considerable variations have occurred from year to year since 1960 probably because of variations in the amount of fallout. Since plankton moves with the currents it is a poor monitor of localized changes in radioactivity such as would be expected at Big Rock Point.

The radioactivity of the other biota collected at Big Rock Point has been generally higher since 1962 than it has been at either Nine Mile Point or Mount McSauba Point. The largest difference occurred in the periphyton and filamentous algae (Figures 4 and 5). Crawfish and shore minnows also had higher counts at Big Rock Point than elsewhere (Figures 6 and 7). Despite these increases it is significant that these higher counts are not greater than those found before the reactor went critical.

A general rise in the radioactivity was observed in 1963. Since this also occurred in watercourses distant from Big Rock (Figure 2) it is reasonable to attribute the rise to increases in fallout from nuclear testing. From this 1963 high a general decline in radioactivity has taken place except for the biota in the immediate vicinity of the Big Rock Point Reactor.

Field collections by: Carlos M. Fetterolf, Jr.,
Michael E. Newton,
D. James Seeburger,
John G. Robinson,
Robert F. Carr,
Aquatic Biologists

Radiological analyses by: Russel Krueger, Chemist

Report by: Carlos M. Fetterolf, Jr., Chief
Water Quality Appraisal Unit
John G. Robinson
Michael E. Newton

January 24, 1968

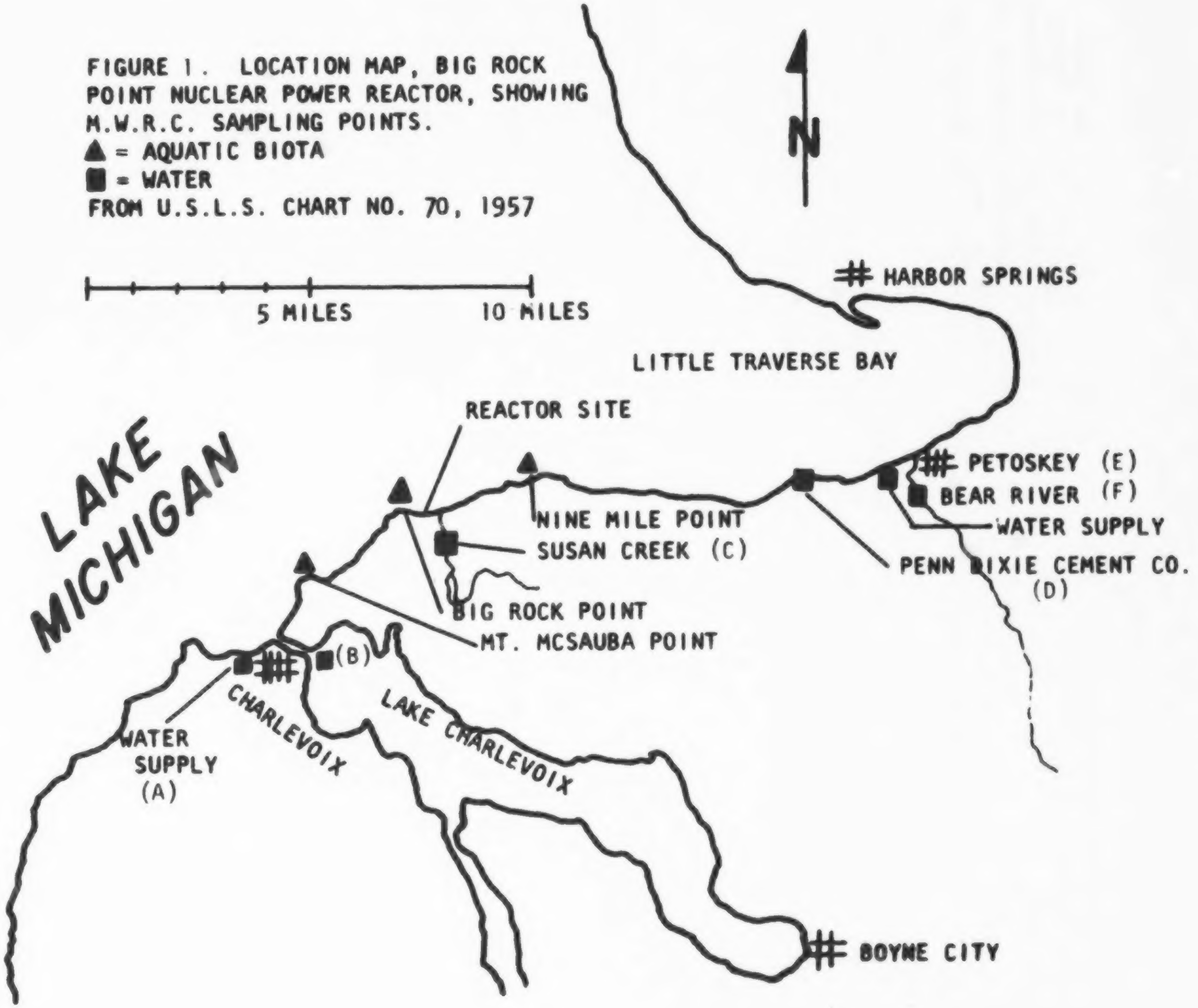

5 MILES
10 MILES
HARBOR SPRINGS
LITTLE TRAVERSE BAY
REACTOR SITE
LAKE MICHIGAN
PETOSKEY (E)
BEAR RIVER (F)
WATER SUPPLY
NINE MILE POINT
SUSAN CREEK (C)
PENN DIXIE CEMENT CO. (D)
BIG ROCK POINT
MT. MCSAUBA POINT
(B)
CHARLEVOIX
LAKE CHARLEVOIX
WATER SUPPLY (A)
BOYNE CITY

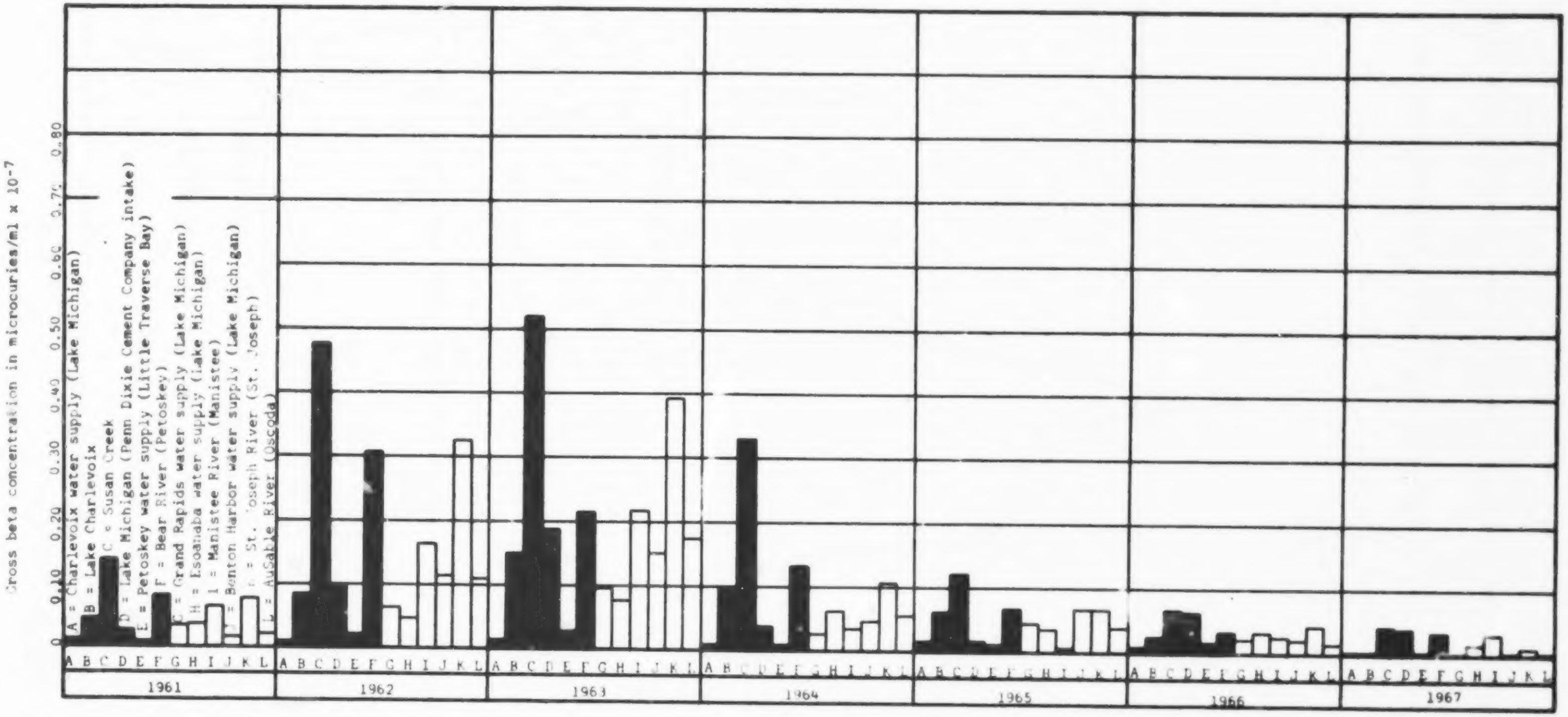
FIGURE 1. LOCATION MAP, BIG ROCK POINT NUCLEAR POWER REACTOR, SHOWING M.W.R.C. SAMPLING POINTS.

▲ = AQUATIC BIOTA

■ = WATER

FROM U.S.L.S. CHART NO. 70, 1957

Figure 2. Annual radiological concentration averages of monthly water samples taken in the vicinity of Big Rock Point Nuclear Reactor (■) and other locations (□), 1961-1967.



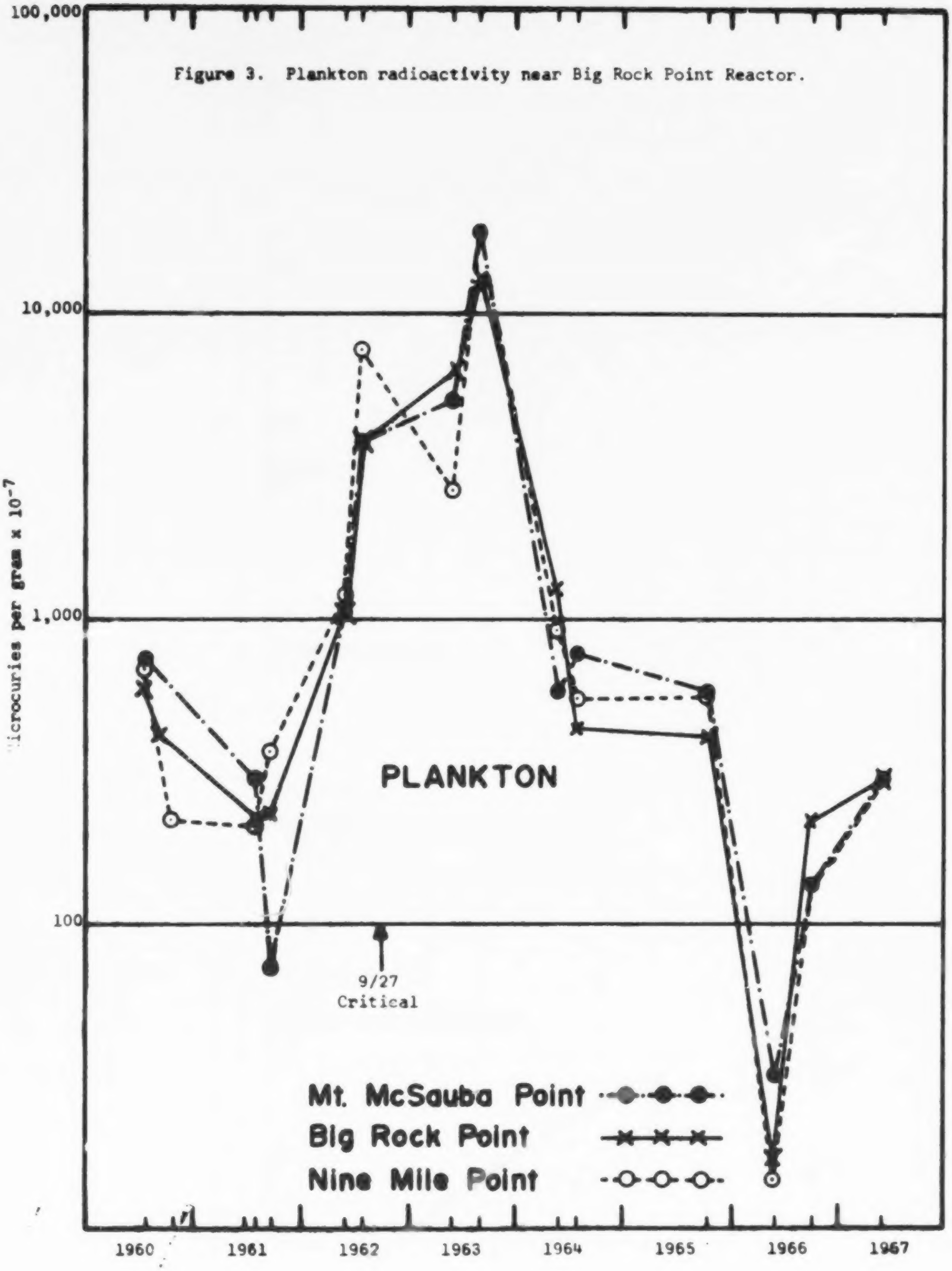


Figure 3. Plankton radioactivity near Big Rock Point Reactor.

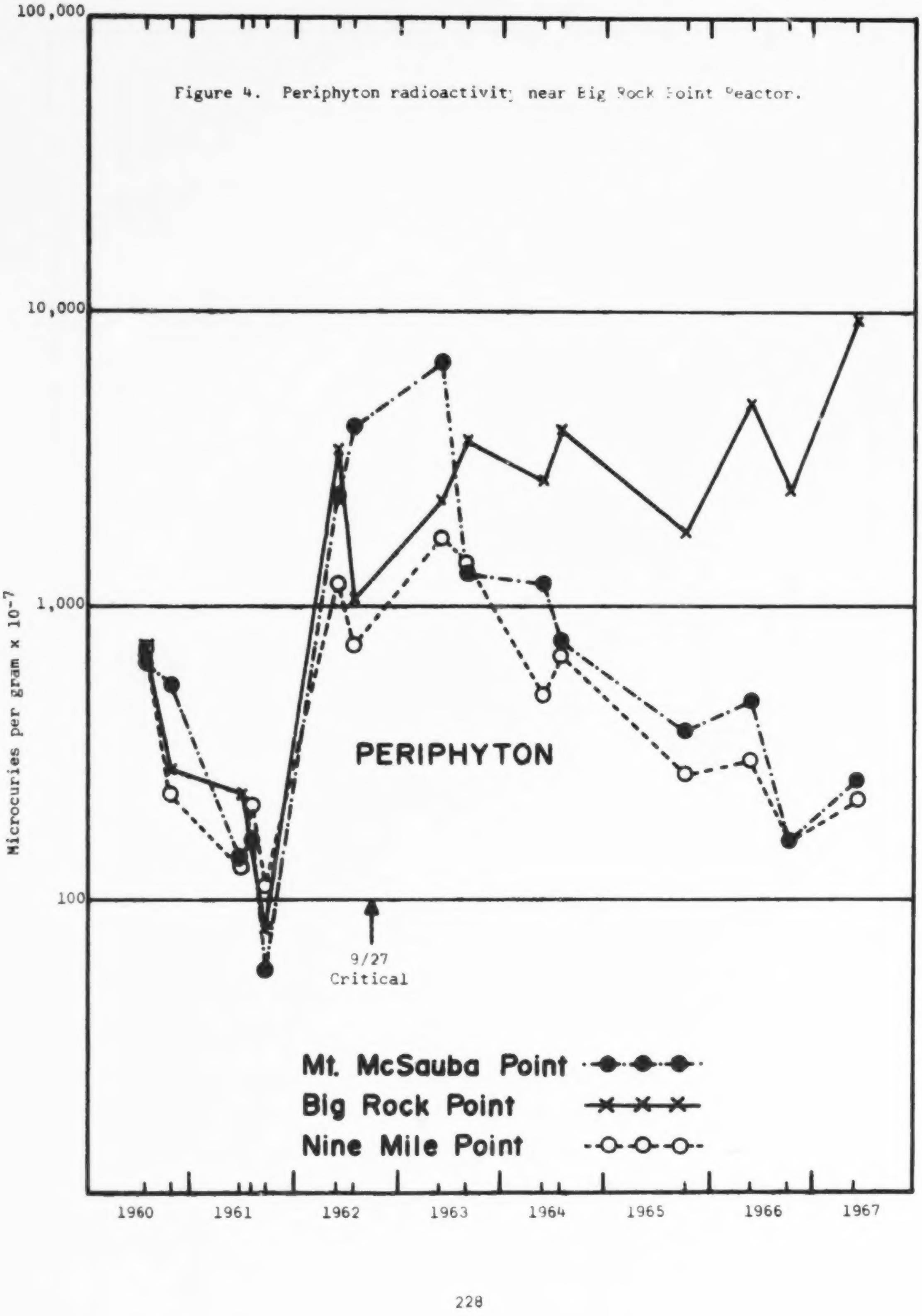


Figure 4. Periphyton radioactivity near Big Rock Point Reactor.

Figure 5. Filamentous algae radioactivity near Big Rock Point Reactor.

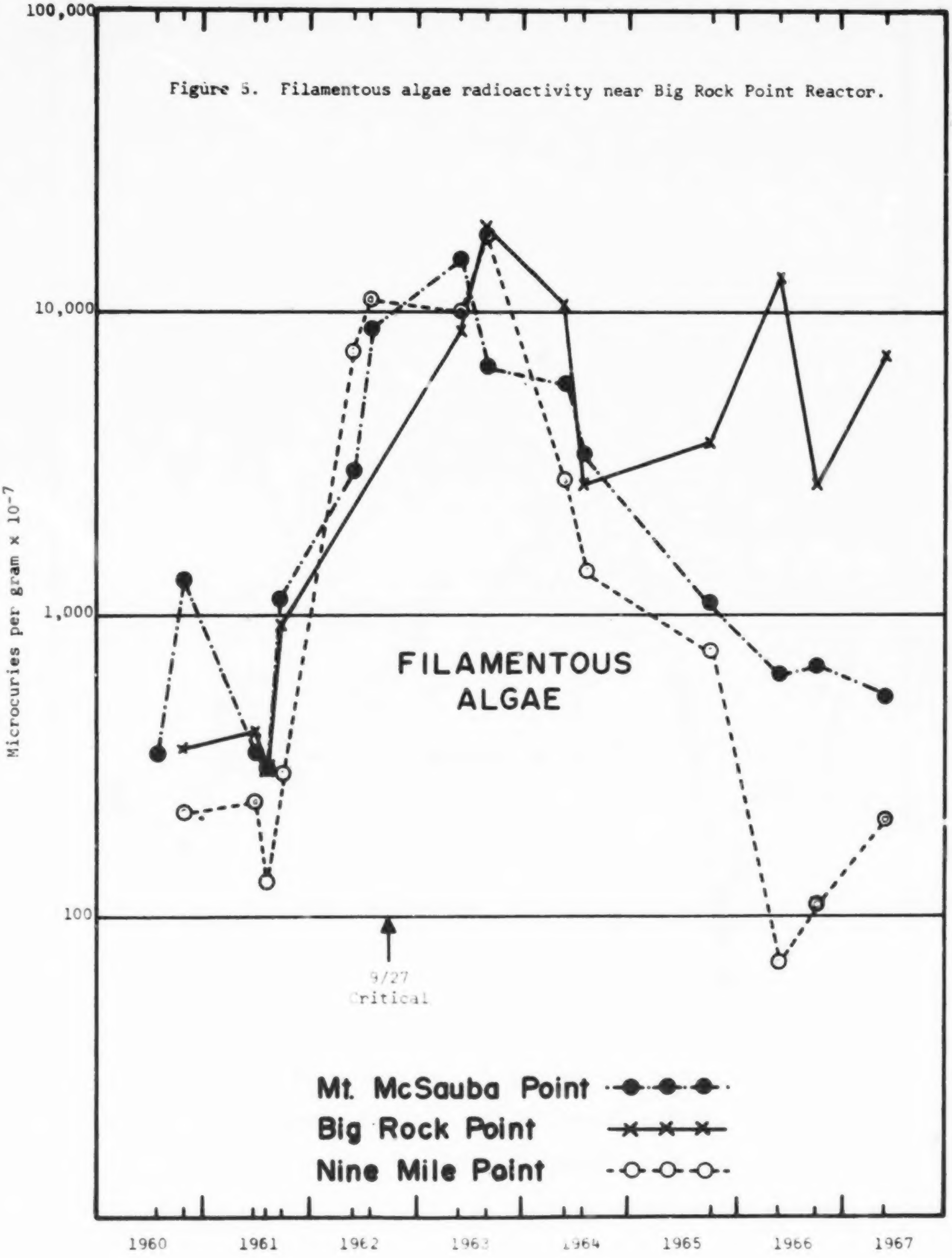


Figure 6. Crayfish radioactivity near Big Rock Point Reactor.

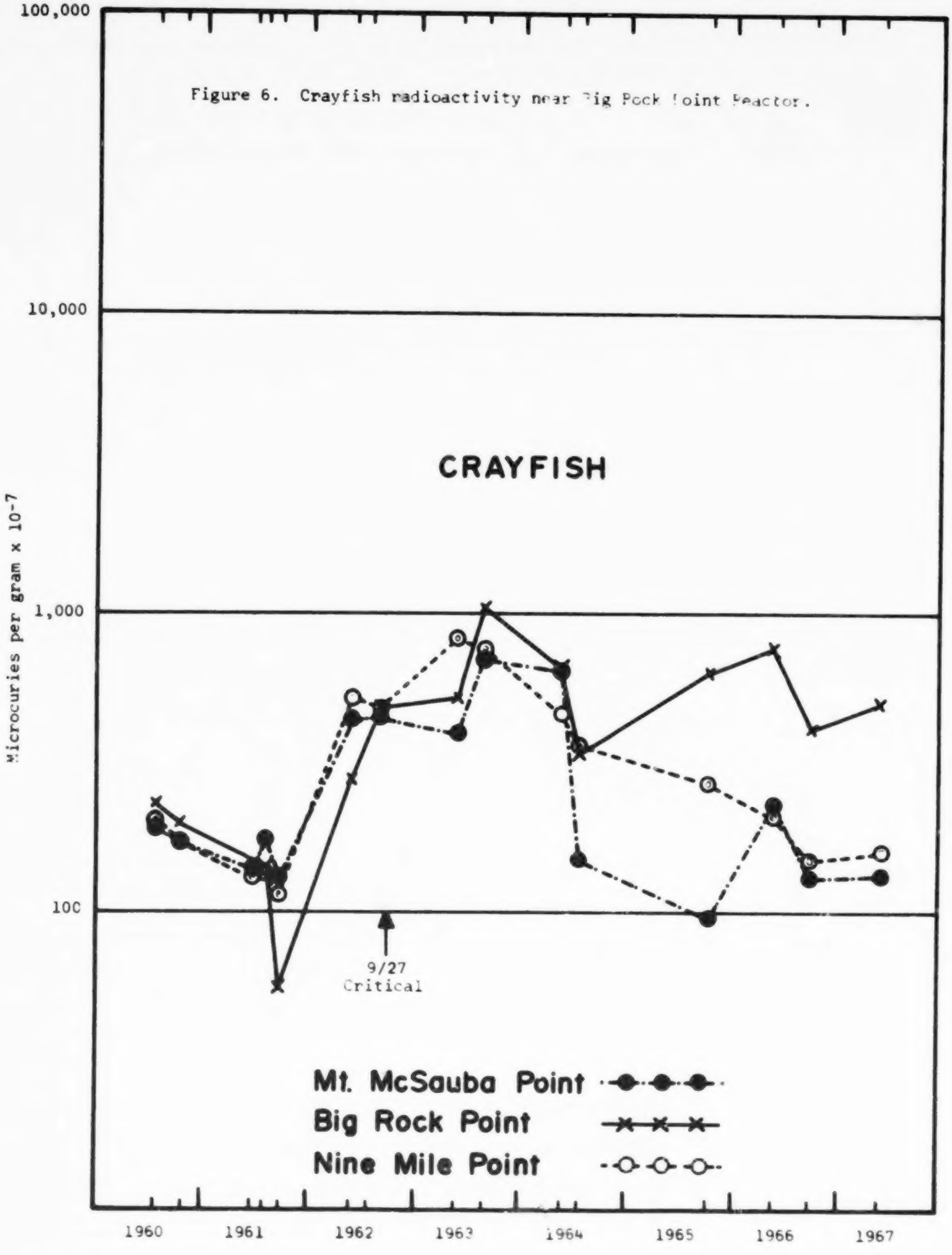
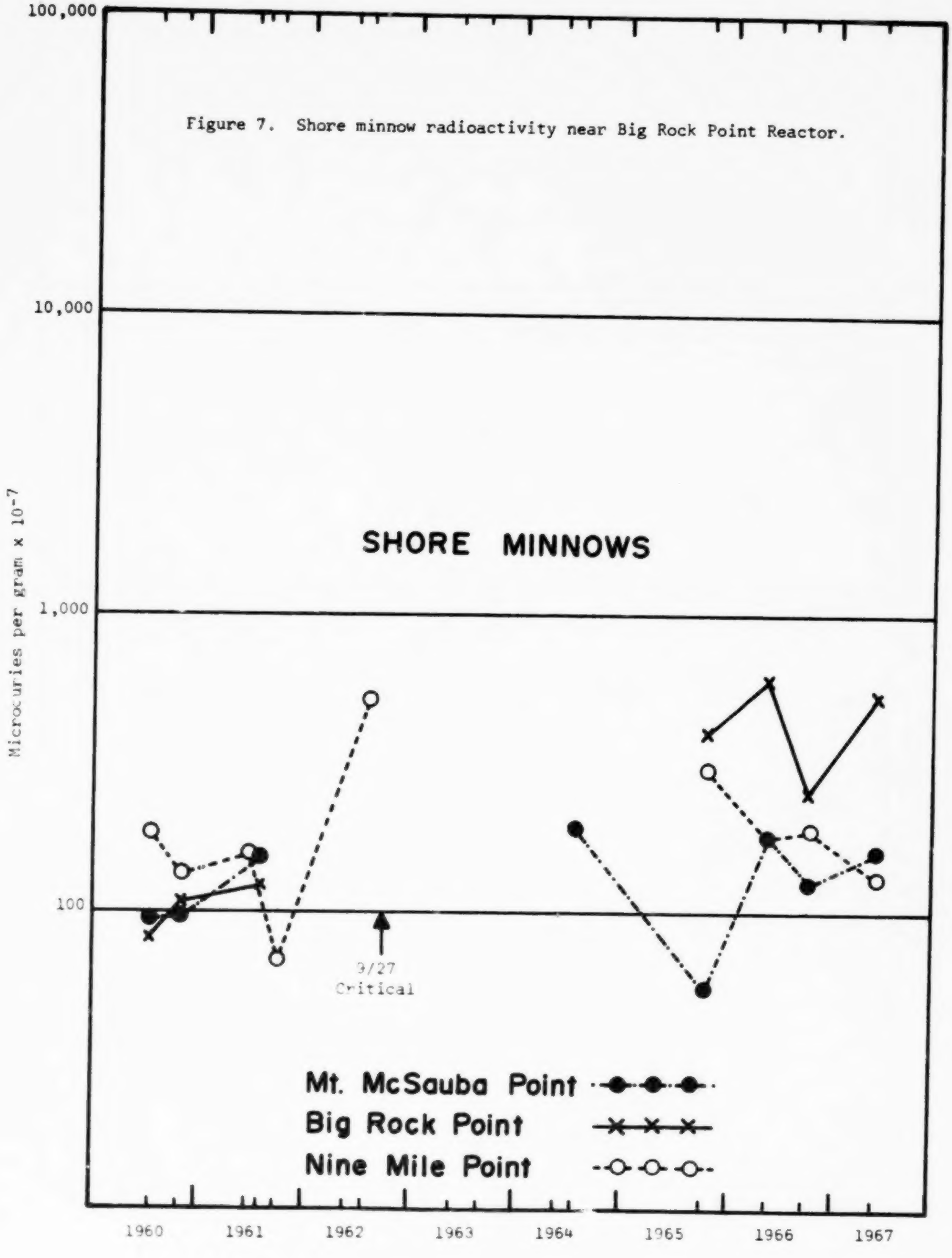


Figure 7. Shore minnow radioactivity near Big Rock Point Reactor.



APPENDIX O

TRIBUTARY MONITORING DATA
AND
SPECIAL SURVEYS

Table 1

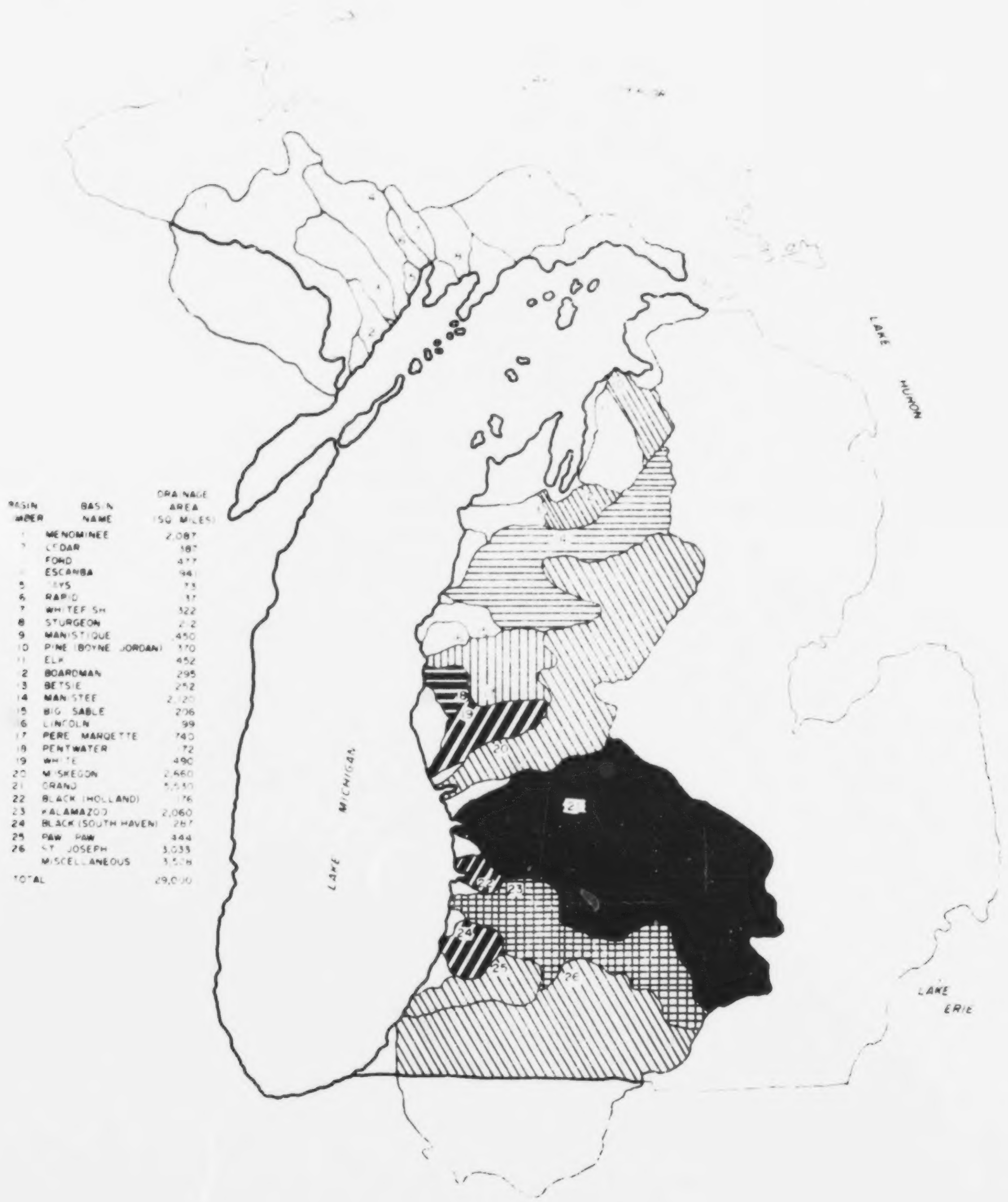
Tributary Water Quality Station Descriptions

Basin No.	River	Location
10	Pine River at Charlevoix	North bank at U.S. Highway 31 bridge in Charlevoix
12	Boardman River at Traverse City	Park Street bridge in Traverse City
14	Manistee River at Manistee	Maple Street bridge in Manistee
17	Pere Marquette River at Ludington	North wall of channel at Coast Guard Station in Ludington
18	Pentwater River at Pentwater	North wall of channel at Coast Guard Station in Pentwater
19	White River near Whitehall	South wall of channel at red tower near Whitehall
20	Muskegon River at Muskegon	South wall of channel at Coast Guard Station in Muskegon
21	Grand River at Grand Haven	South wall of channel below Corps of Engineers in Grand Haven
22	Black River at Holland	South wall of channel across from State Park in Holland
23	Kalamazoo River at Saugatuck	U.S. Highway 31 bridge in Saugatuck
24	Black River at South Haven	Dyckman Avenue bridge in South Haven
*26	St. Joseph River at St. Joseph	Chesapeake and Ohio Railroad bridge, below U.S. Highway 31 bridge in St. Joseph

*The station at the mouth of the St. Joseph includes flow from the Paw Paw (Basin No. 25).

MAP 1

STATE OF MICHIGAN
MICHIGAN PORTION
LAKE MICHIGAN DRAINAGE BASIN
BASINS IN WATER QUALITY MONITORING PROGRAM



BASIN NUMBER	BASIN NAME	DRAINAGE AREA (SQ MILES)
1	MENOMINEE	2,087
2	CEDAR	387
	FORD	477
	ESCANABA	941
5	DAYS	73
6	RAPID	137
7	WHITEFISH	322
8	STURGEON	212
9	MANISTIQUE	1,450
10	PINE (BOYNE JORDAN)	370
11	ELK	452
12	BOARDMAN	295
13	BETSIE	252
14	MANISTEE	2,120
15	BIG SABLE	206
16	LINCOLN	99
17	PERE MARQUETTE	740
18	PENTWATER	172
19	WHITE	490
20	MUSKEGON	2,660
21	GRAND	5,530
22	BLACK (HOLLAND)	176
23	KALAMAZOO	2,060
24	BLACK (SOUTH HAVEN)	287
25	PAW PAW	444
26	ST. JOSEPH	3,033
	MISCELLANEOUS	3,528
TOTAL		29,000

FIGURE I

SUMMARY OF SELECTED WATER QUALITY PARAMETERS
LAKE MICHIGAN TRIBUTARIES
1965—1966

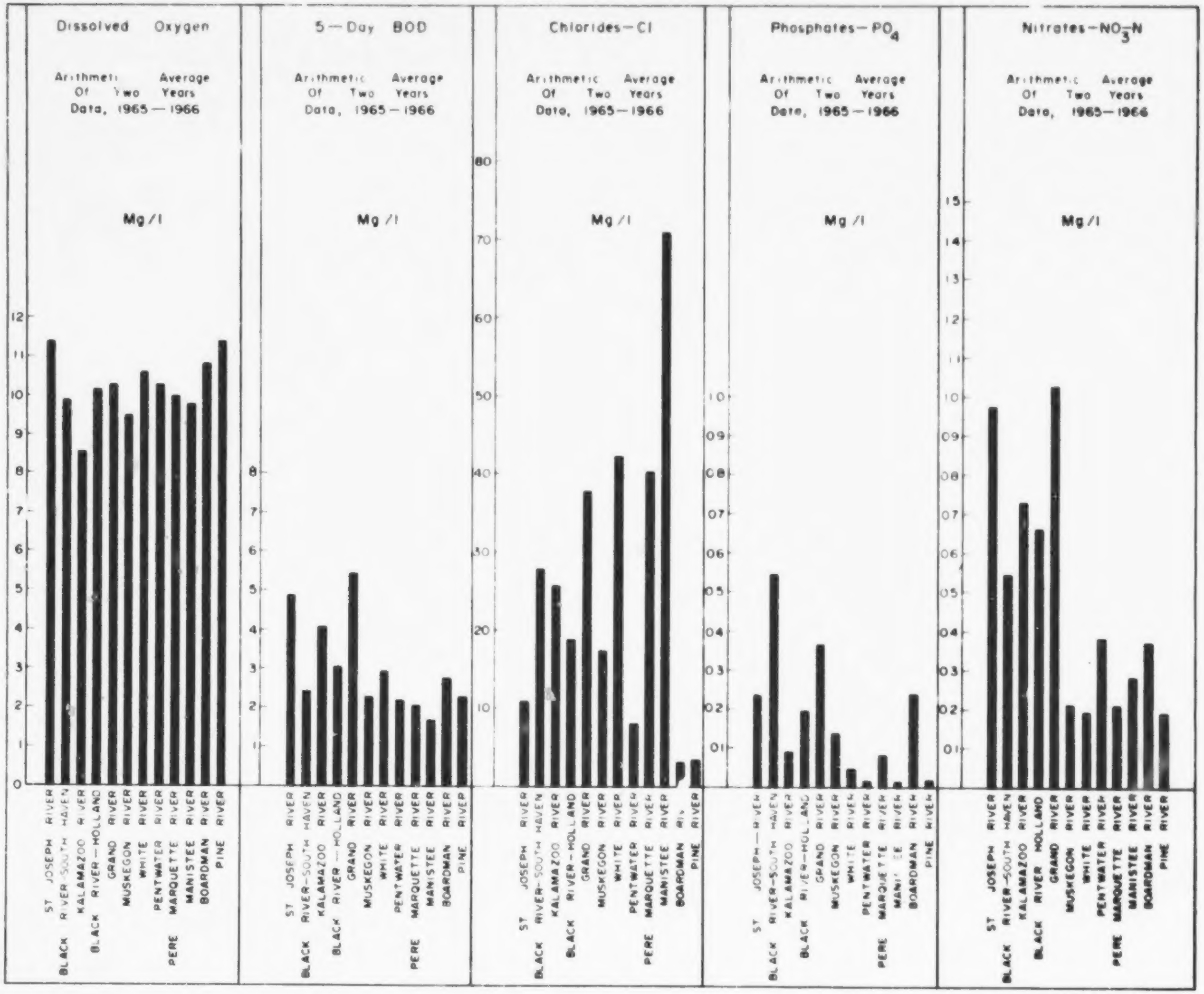


TABLE 2

SUMMARY OF SELECTED WATER QUALITY PARAMETERS IN LAKE MICHIGAN TRIBUTARIES

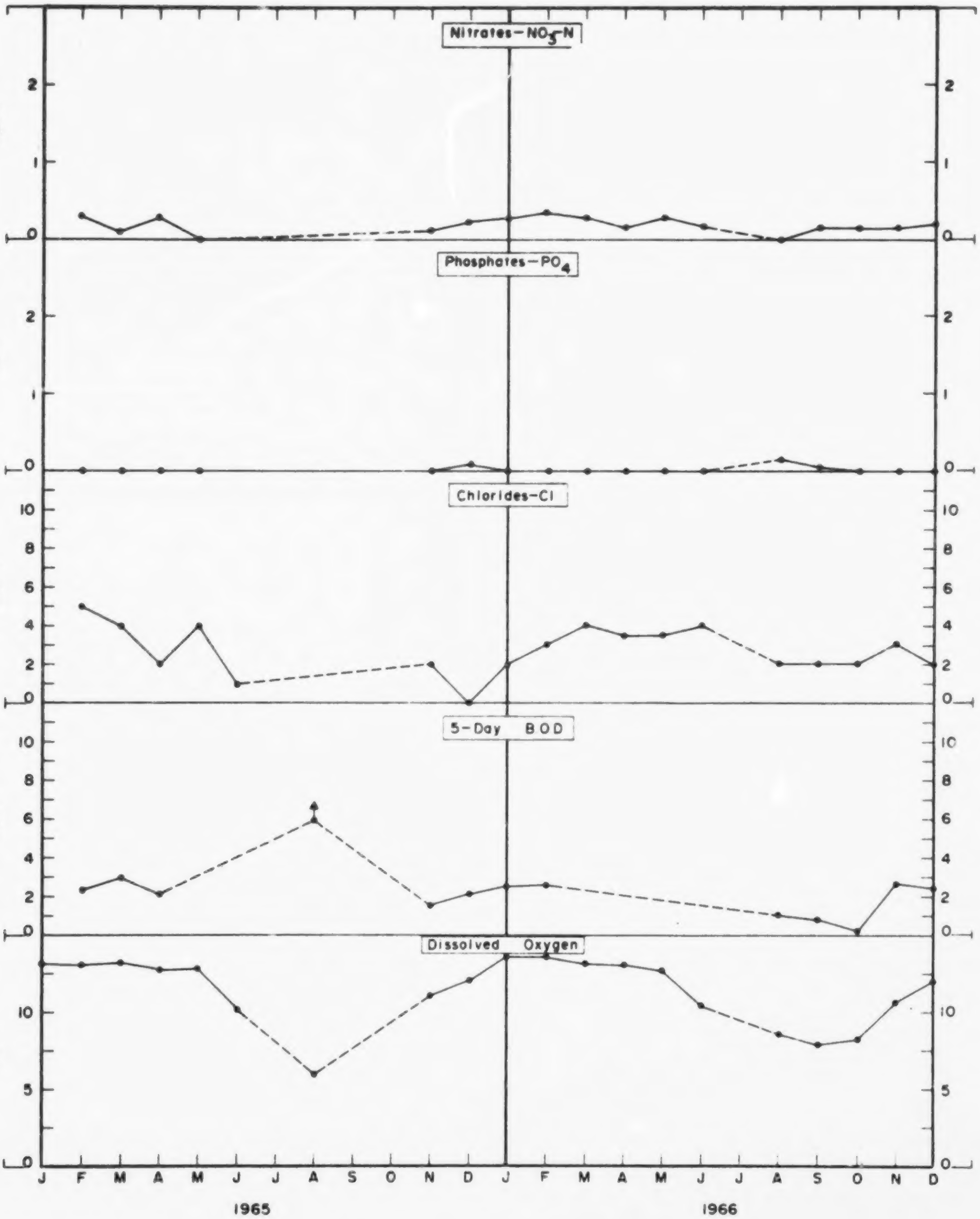
Surface Water	Parameter	1967 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Pine River, Charlevoix	DO	11.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Boardman River, Traverse City	DO	11.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	2.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Manistee River, Manistee	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pere Marquette River, Ludington	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pentwater River, Pentwater	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
White River, Whitehall	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Muskegon River, Muskegon	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Grand River, Grand Haven	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Black River, Holland	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kalamazoo River, Saugatuck	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Black River, South Haven	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St. Joseph River, St. Joseph	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Surface Water	Parameter	1968 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Pine River, Charlevoix	DO	[illegible]	[illegible]	[illegible]	[illegible]	12.8	[illegible]	--	8.8	7.9	8.2	10.6	12.0
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	1.0	0.8	0.2	2.6	2.4
	Cl	[illegible]	[illegible]	4	4	4	4	--	2	2	2	3	12
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	0.15	0.05	0.00	0.00	0.00
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.15	--	0.00	0.15	0.13	0.15	0.20
Boardman River, Traverse City	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.9	--	8.5	7.8	8.2	11.0	12.3
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	3.0	2.2	2.0	3.4	3.3
	Cl	[illegible]	1	[illegible]	1	2	4	--	4	3	4	8	2
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	0.55	[illegible]	0.35	0.30	0.15
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.25	--	0.00	0.21	0.30	0.31	0.51
Manistee River, Manistee	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.8	--	[illegible]	7.6	7.8	10.8	11.9
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	[illegible]	0.8	2.0	2.4
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	84	72	--	88	74	210	124	50
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	0.00	0.00	0.00	0.00	0.00
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	0.00	[illegible]	0.10	0.30	0.32
Pere Marquette River, Ludington	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.4	8.4	11.2	[illegible]	8.7	11.1	11.3
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	--	--	1.8	--	[illegible]	1.9	2.8	3.0
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	24	44	[illegible]	50	44	32
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	0.20	0.02
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.06	0.25	0.27
Pentwater River, Pentwater	DO	[illegible]	[illegible]	[illegible]	[illegible]	11.6	11.2	8.4	9.0	[illegible]	7.0	11.4	11.8
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8	--	[illegible]	[illegible]	1.9	3.1
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10	8	8	6	8
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10	[illegible]	0.00	0.00	0.00
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10	0.32	0.45
White River, Whitehall	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.8	12.3
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.3	3.0
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42	68	42	66
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	[illegible]	0.00
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	[illegible]	0.24
Muskegon River, Muskegon	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.4	11.7
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.5	2.8	3.7
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18	18	18	20	20	22
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10	0.10	0.18
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	0.10	0.20
Grand River, Grand Haven	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.8	[illegible]	11.3	11.7
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	7.7	4.5
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48	55	54	48	48	36
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.25	[illegible]	0.30	0.35	0.40	0.30	0.55
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	[illegible]	0.21	0.39	1.8
Black River, Holland	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.4	8.8	8.8	8.0	--	12.6
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.6	--	2.5	2.0	--	4.0
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16	17	24	25	20	--	30
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10	--	0.32
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	--	1.01
Kalamazoo River, Saugatuck	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	7.4	--	11.2
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	2.8	[illegible]	--	4.7
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	32	30	32	--	30
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	0.10	0.00	0.15	--	0.22
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.10	0.41	--	1.2
Black River, South Haven	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	--	--	12.0
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.4	--	--	3.0
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	22	--	--	30
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	0.35	--	--	0.25
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	0.25	0.13	--	--	0.67
St. Joseph River, St. Joseph	DO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	--	--	12.2
	BOD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.2	--	--	4.4
	Cl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	12	--	--	14
	PO_4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	0.20	[illegible]	--	--	0.32
	NO_3-N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]	0.23	--	--	1.5

Note: Monthly results shown in the above chart were obtained from the "Water Quality Monitoring Program", 1967 and 1968 water quality records prepared and published by the Michigan Water Resources Commission. Results are also shown graphically on the following charts.

FIGURE 2

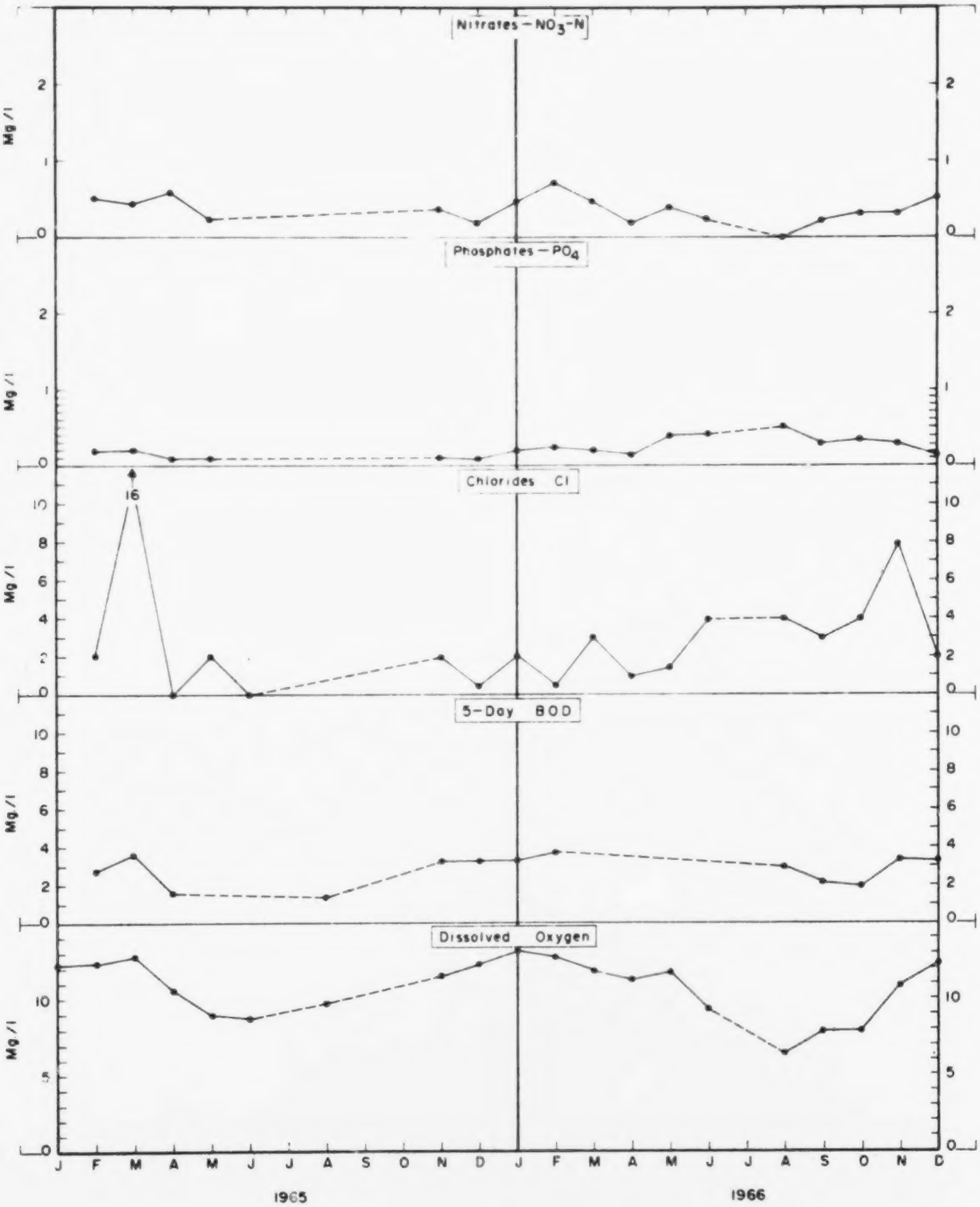
PINE RIVER
CHARLEVOIX



NOTE DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

FIGURE 3

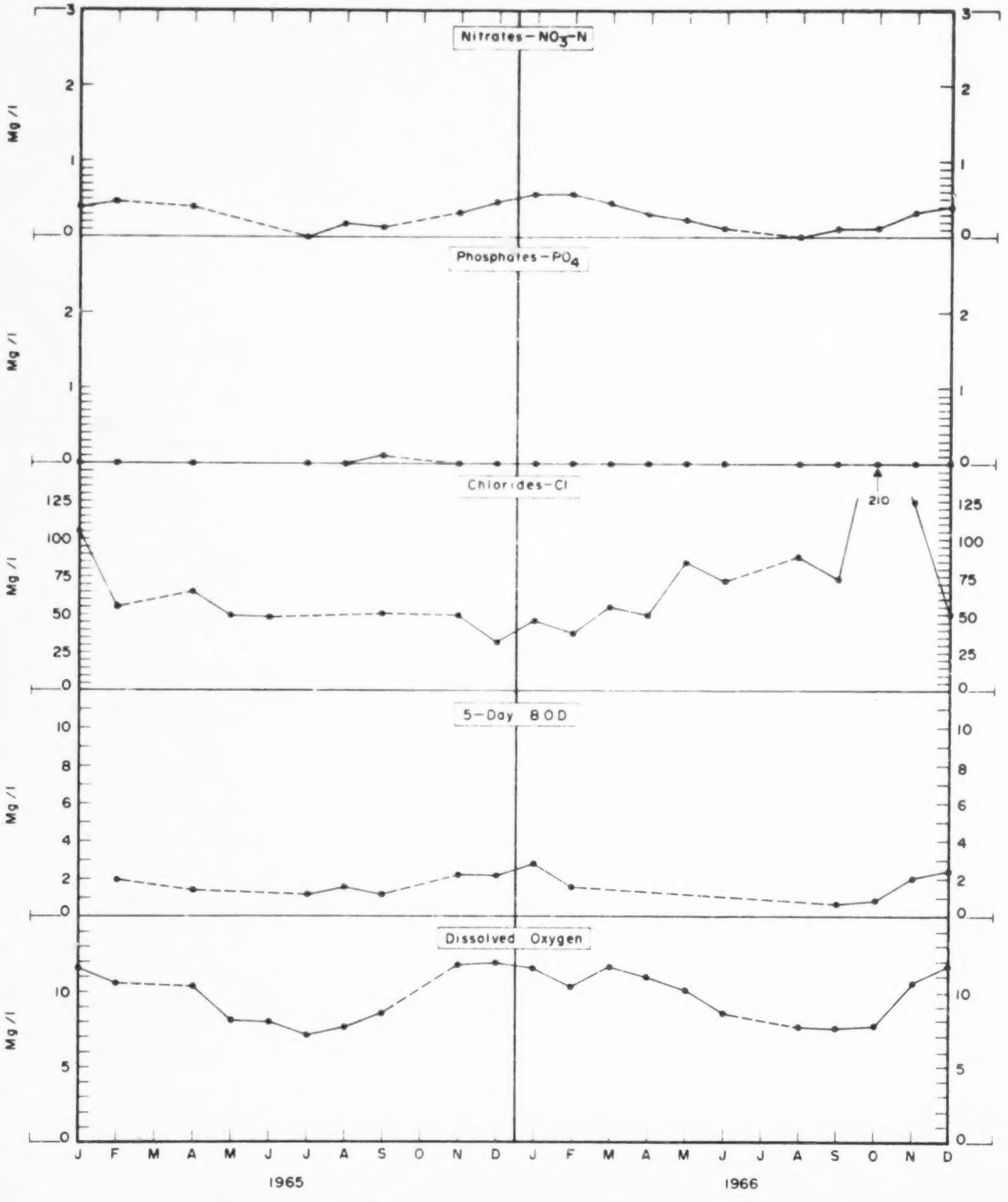
BOARDMAN RIVER
TRAVERSE CITY



NOTE DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

FIGURE 4

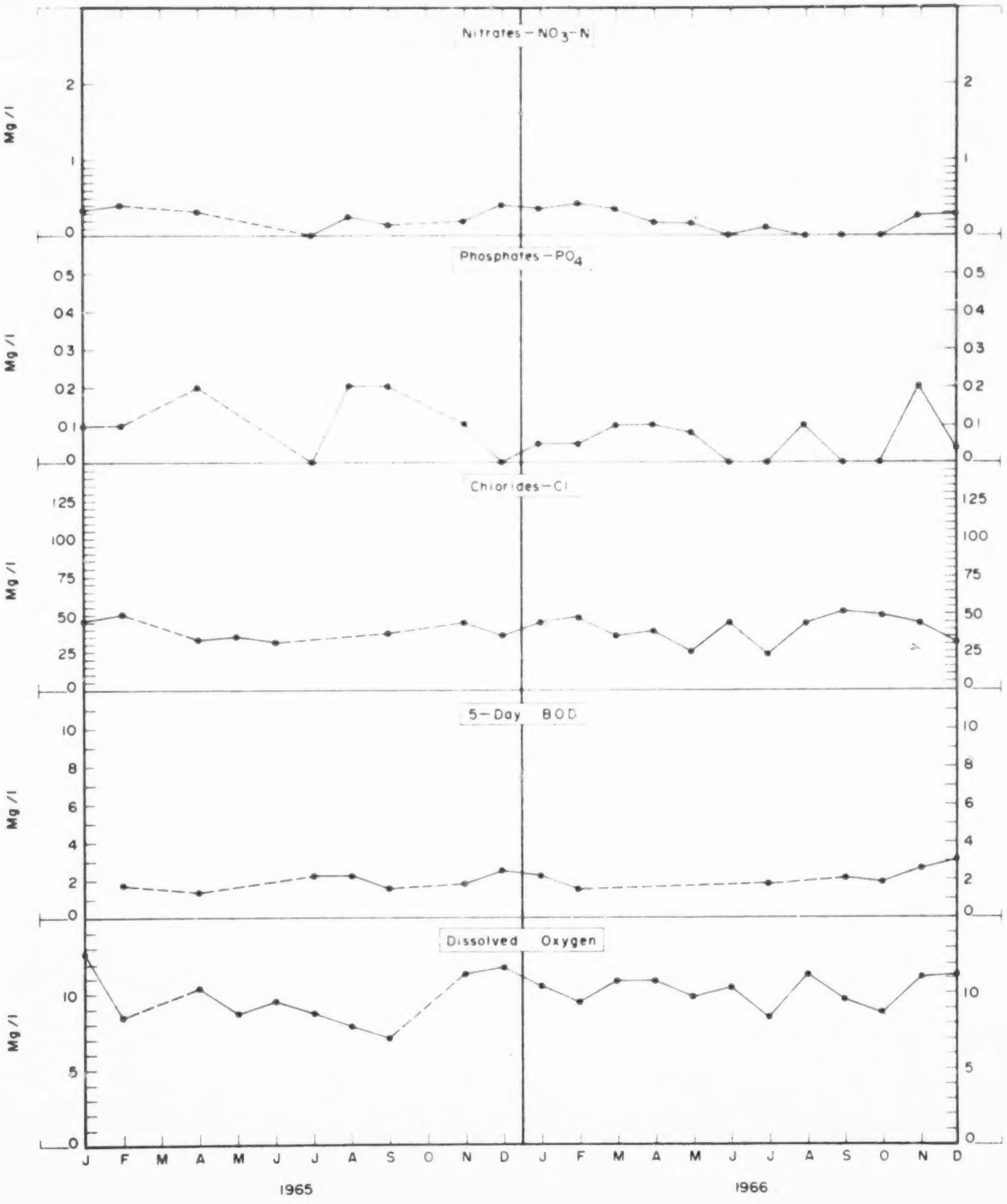
MANISTEE RIVER
MANISTEE



NOTE DASH LINES INDICATE PERIODS
FOR WHICH DATA IS NOT AVAILABLE

FIGURE 5

PERE MARQUETTE RIVER
LUDINGTON

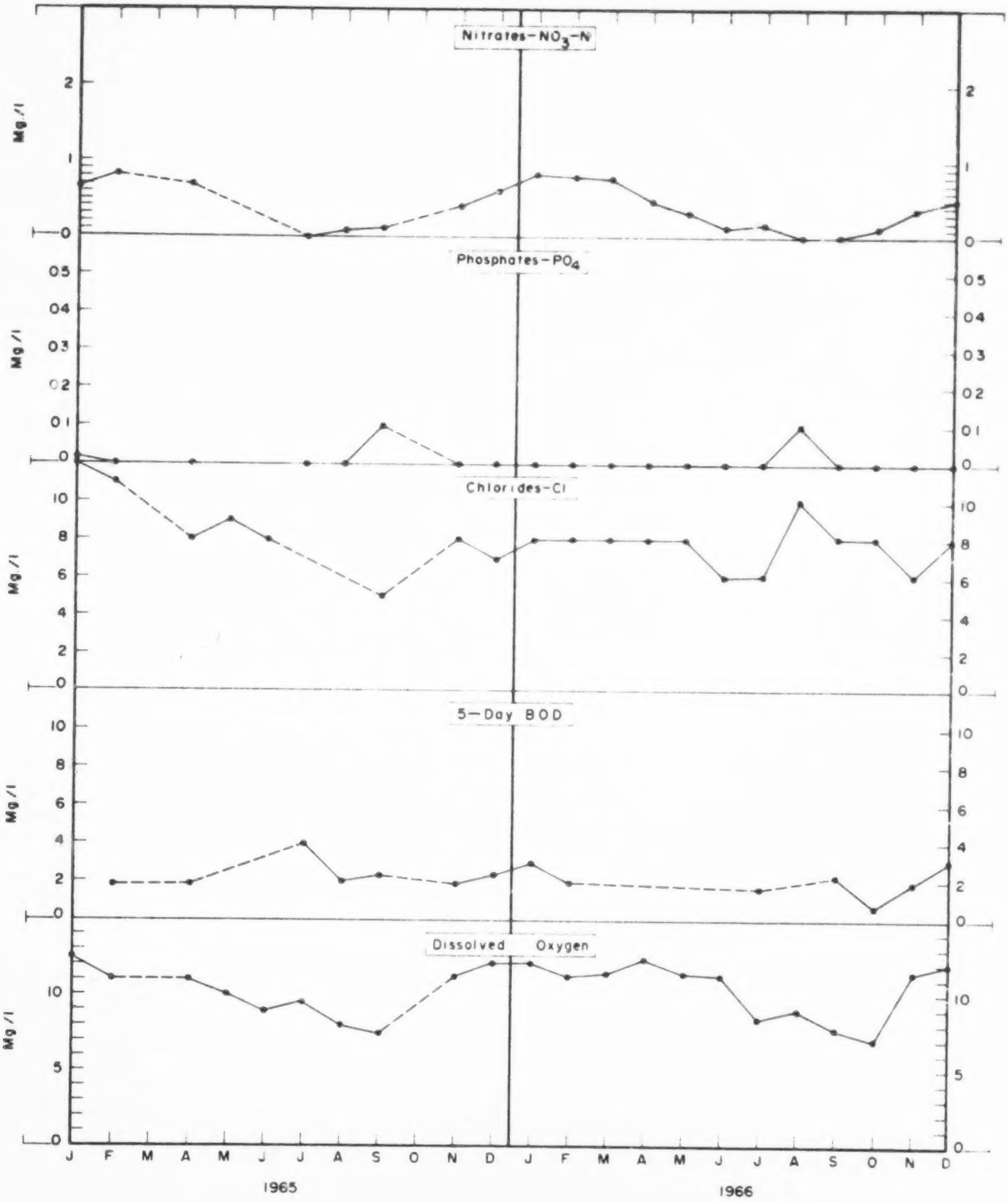


NOTE: DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

2854

FIGURE 6

PENTWATER RIVER
PENTWATER

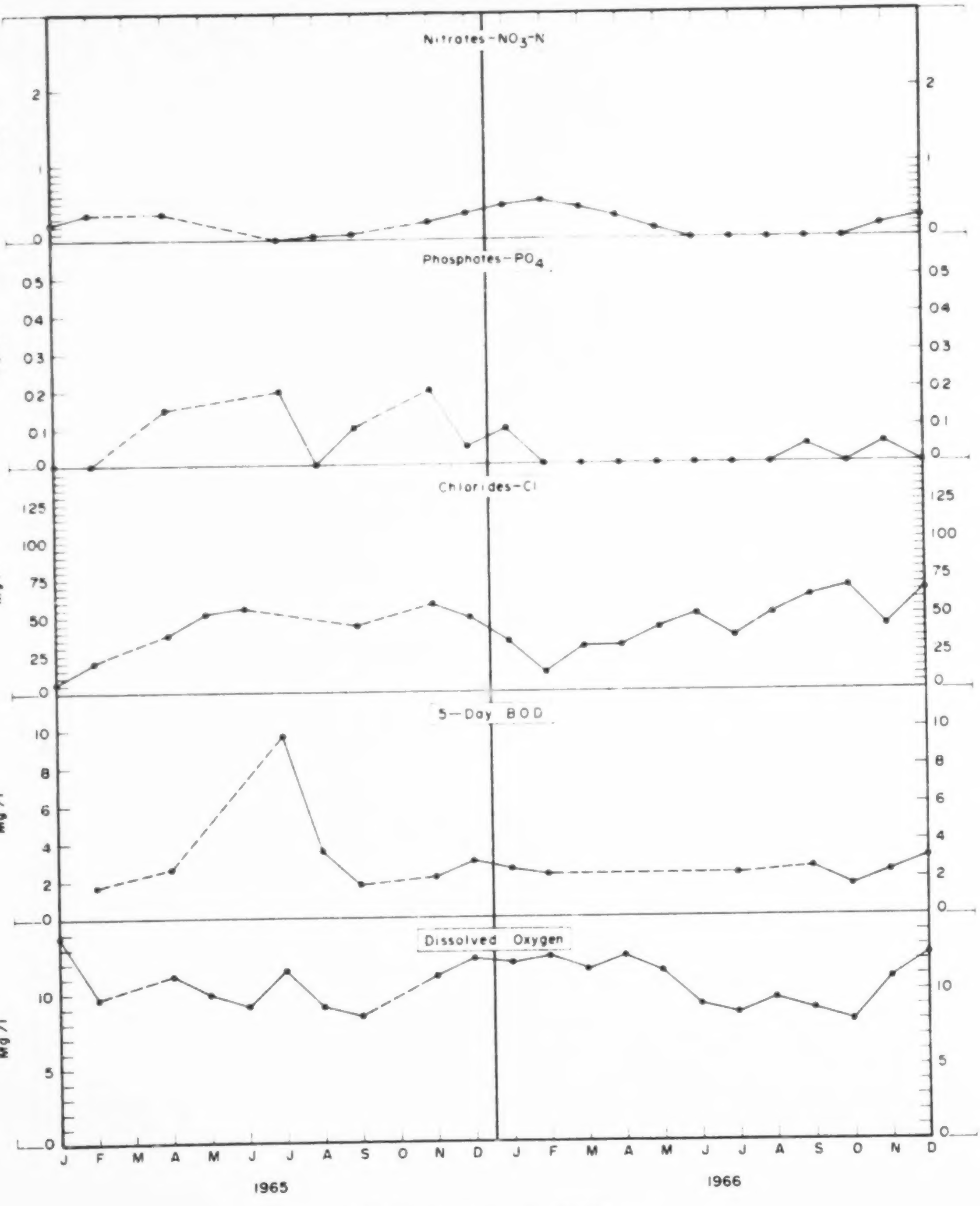


NOTE: DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

FIGURE 7

WHITE RIVER

WHITEHALL

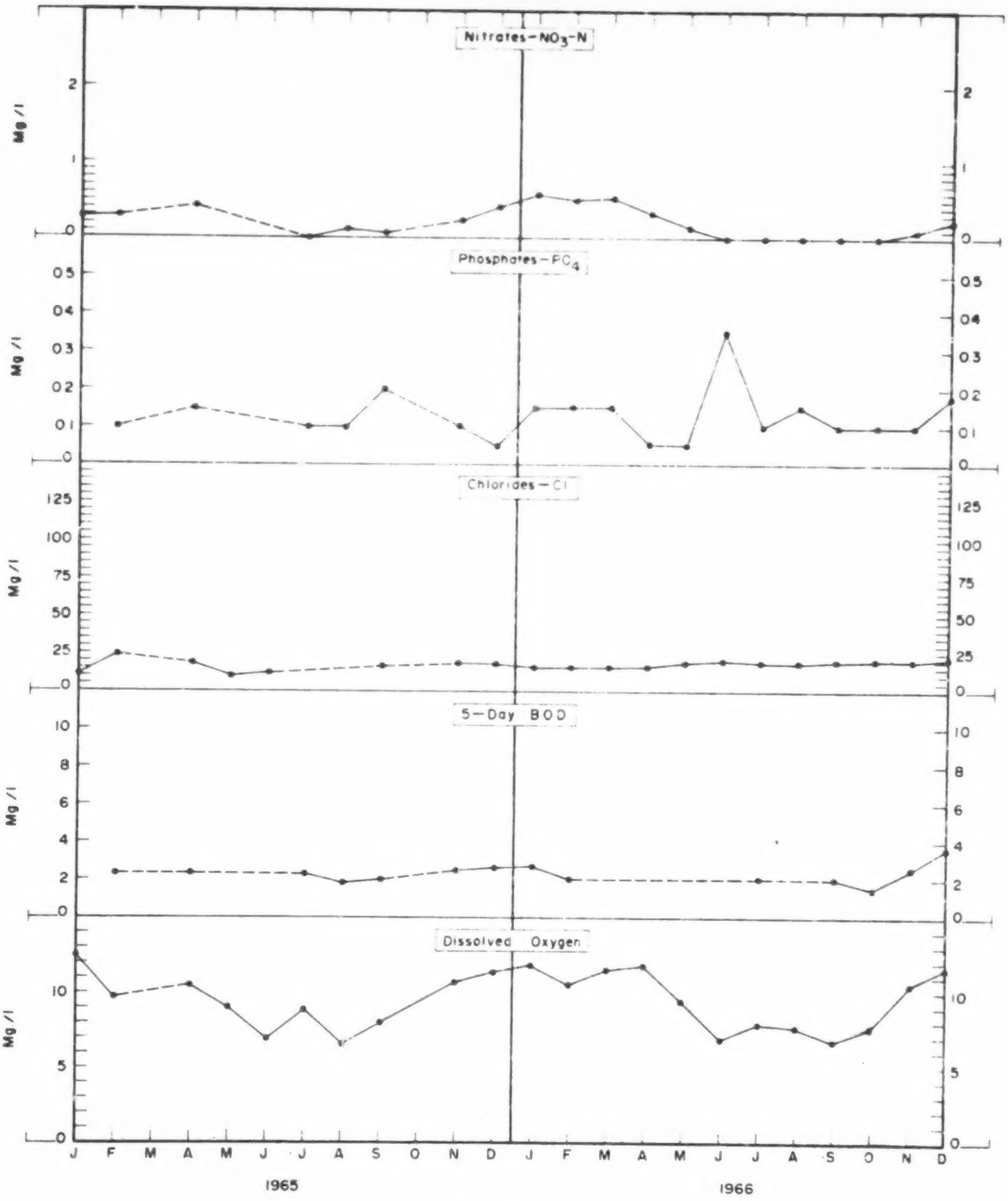


NOTE DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

FIGURE 8

MUSKEGON RIVER

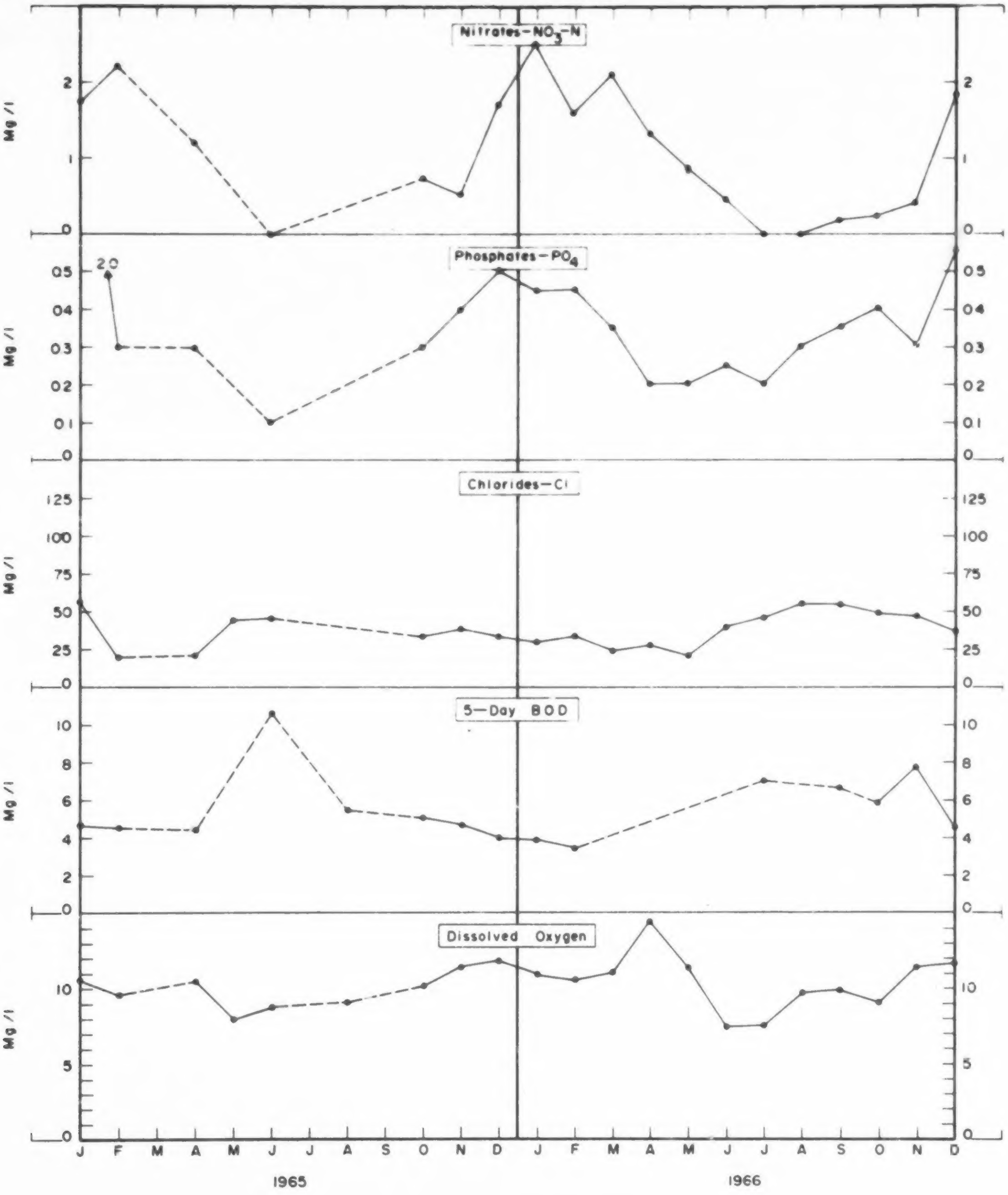
MUSKEGON



NOTE DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

FIGURE 9

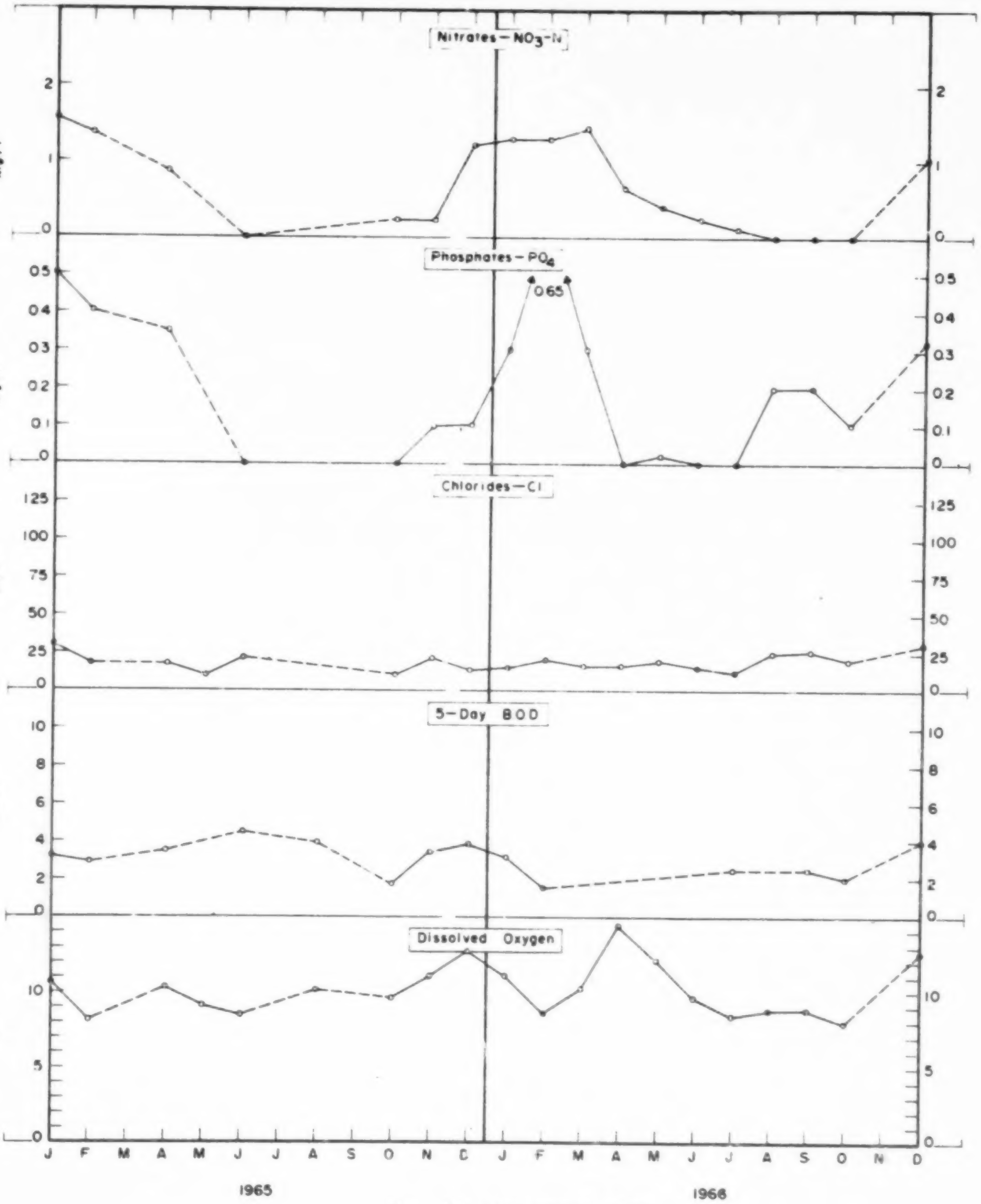
GRAND RIVER
GRAND HAVEN



NOTE DASH LINES INDICATE PERIODS
FOR WHICH DATA IS NOT AVAILABLE

FIGURE 10

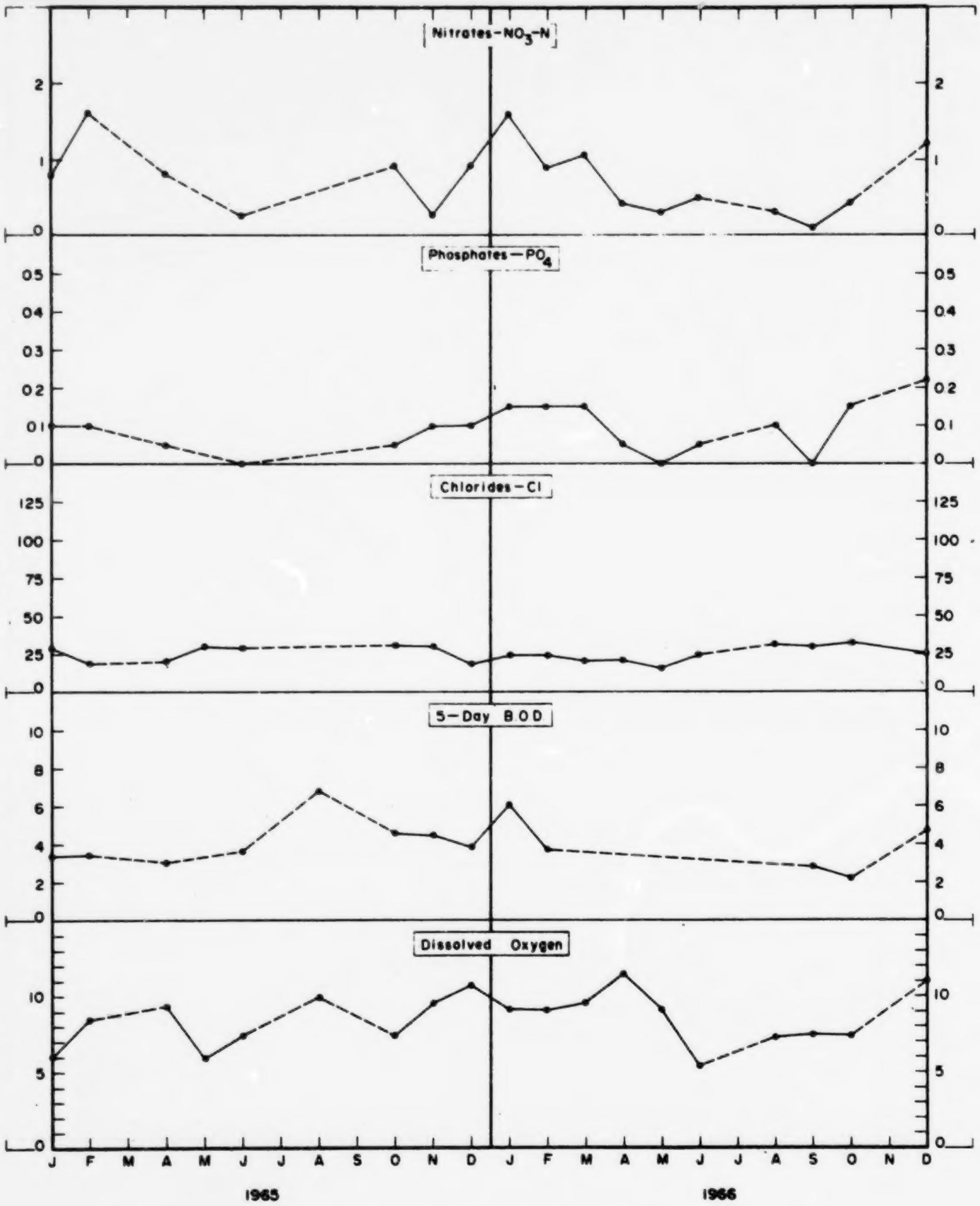
BLACK RIVER
HOLLAND



NOTE DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

FIGURE 11

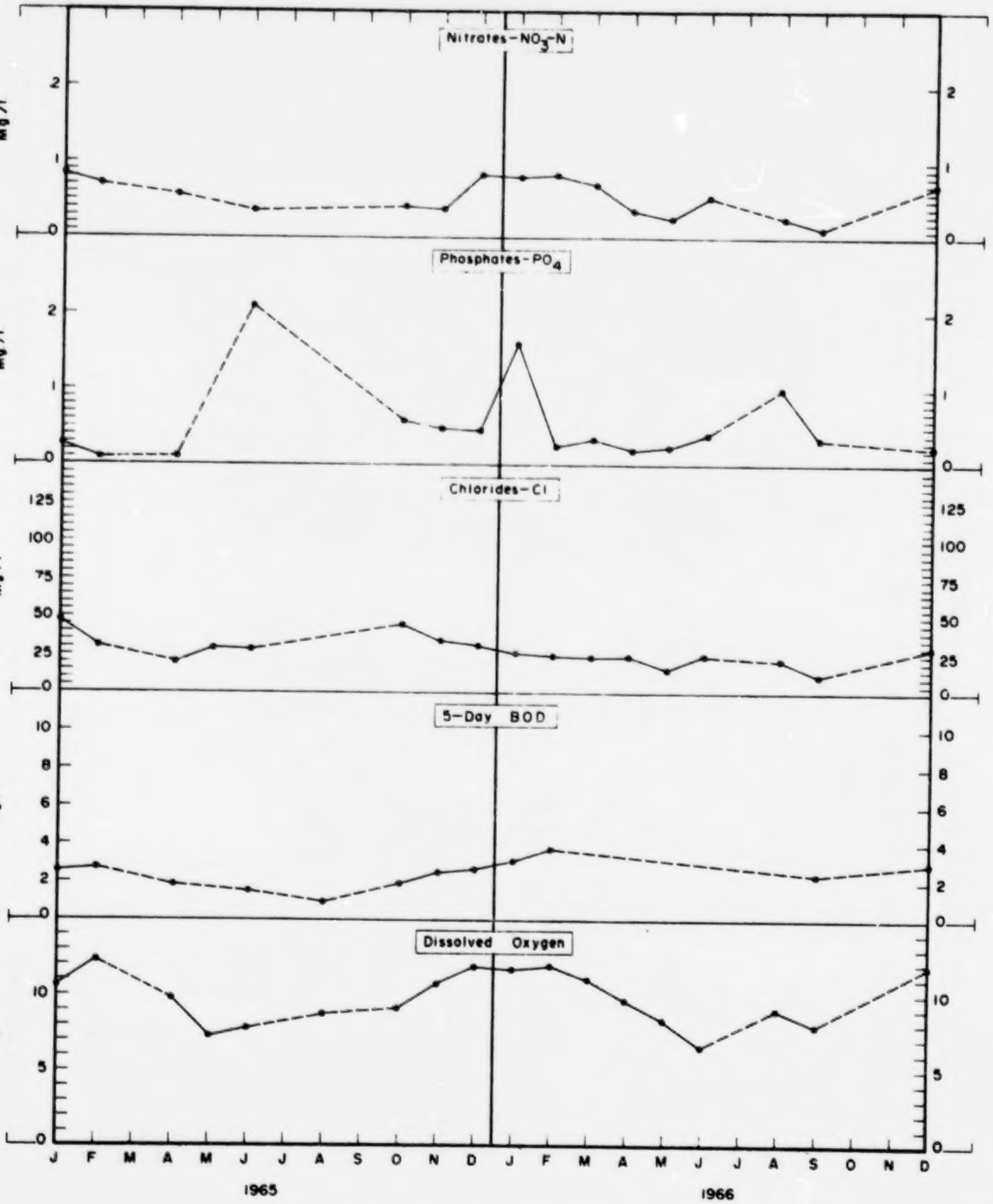
KALAMAZOO RIVER
SAUGATUCK



NOTE DASH LINES INDICATE PERIODS
FOR WHICH DATA IS NOT AVAILABLE

FIGURE 12

BLACK RIVER
SOUTH HAVEN

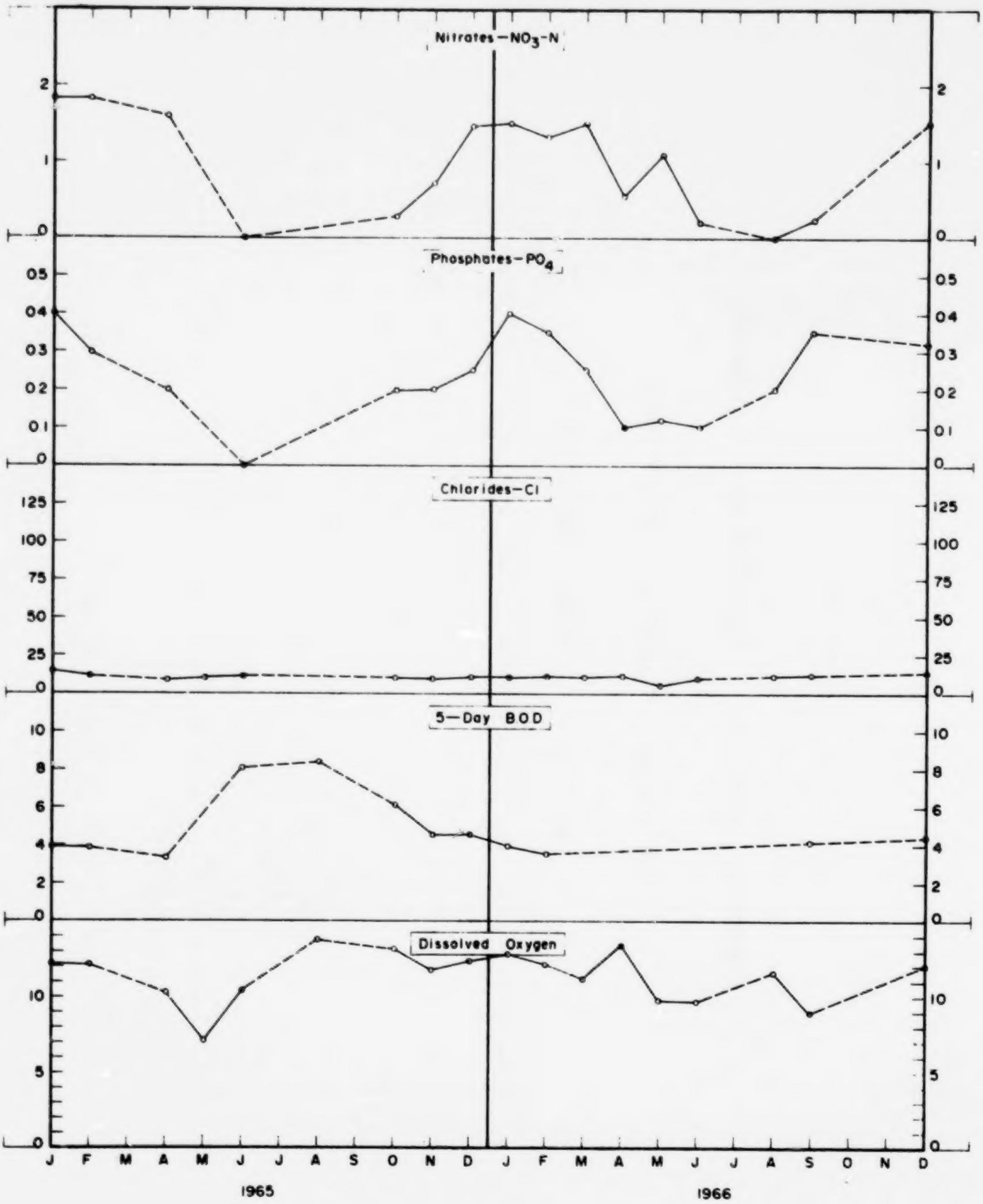


NOTE DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

FIGURE 13

ST. JOSEPH RIVER

ST. JOSEPH



NOTE DASH LINES INDICATE PERIODS FOR WHICH DATA IS NOT AVAILABLE

TABLE 3

WATER QUALITY MONITORING PROGRAM

COLIFORM COUNTS 1965—1966

MONTHLY TEST RESULTS

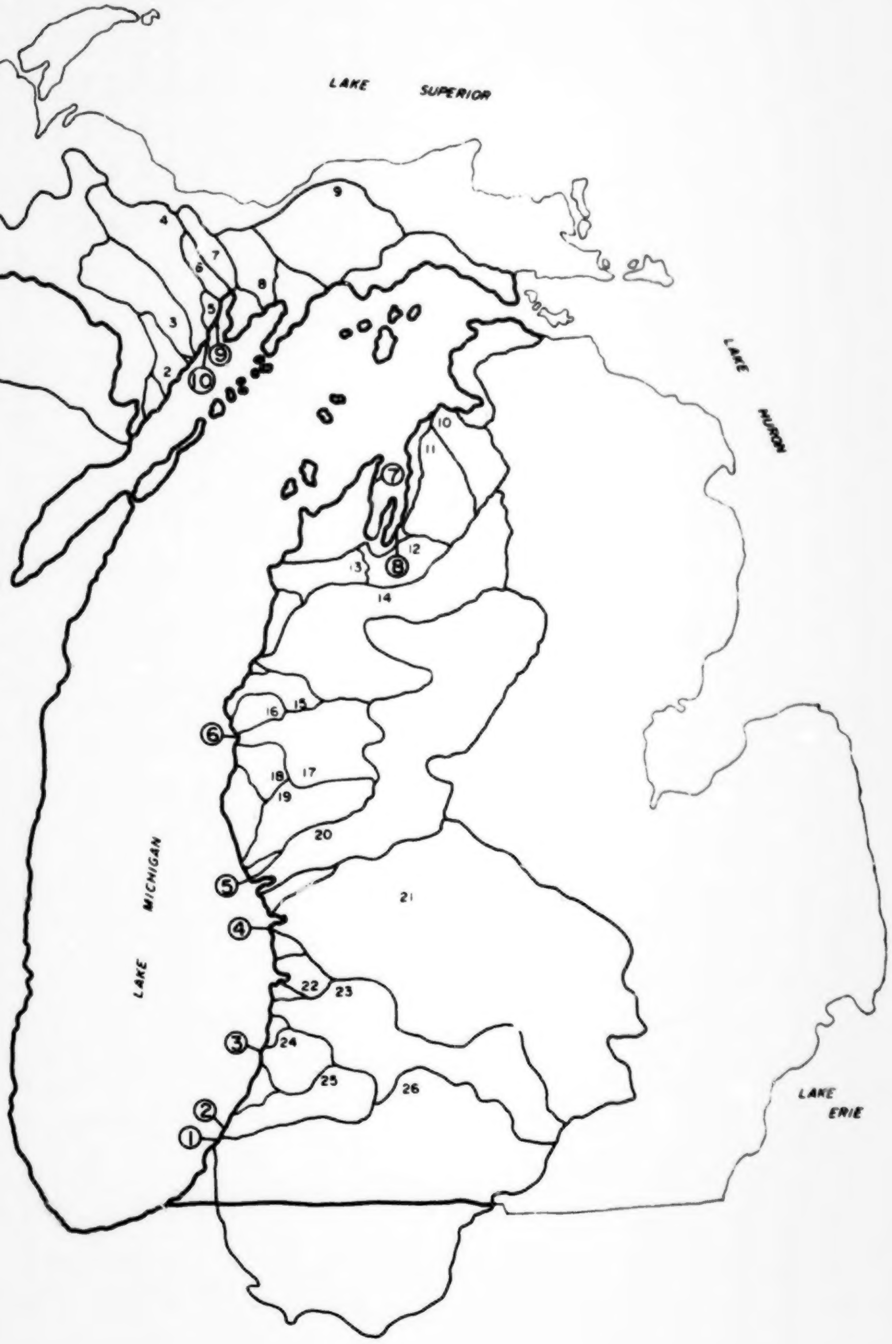
Tributary Monitored	1965 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1966 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Pine River, Charlevoix	4,300	---	---	430	<30	---	---	230	---	---	930	4,300	91	4,300	430	2,300	930	91	---	1,000	400	---	35,[illegible]	5[illegible]
Boardman River, Traverse City	<30	---	36	<[illegible]	---	2,300	---	1,100,000	---	---	<30	<30	<30	<30	<30	930	36	4,300	---	14,000	8,500	---	1[illegible]	<1[illegible]
Manistee River, Manistee	36	---	---	2,300	36	---	390	230	430	---	930	230	430	2,300	4,300	930	150	930	---	<200	200	---	9,200	150
Pere Marquette River, Ludington	91	---	---	1,[illegible]	230	---	2,400	750	430	---	9,300	1,500	230	9,300	91	930	150	91	200	1,600	350	---	14,000	4[illegible]0
Pentwater River, Pentwater	---	---	---	24,[illegible]	73	---	230	930	430	---	4,300	430	430	4,300	91	930	750	73	2,000	600	200	---	3[illegible]	4[illegible]
White River, Whitehall	<30	---	---	36	36	---	390	2[illegible]	36	---	430	<30	36	<30	<30	<30	<30	91	900	200	<100	---	300	[illegible]
Muskegon River, Muskegon	430	---	---	4,[illegible]	1,500	---	2,400	9,300	4,300	---	9,300	46,000	1,500	4,300	2,300	430	2,300	930	2,000	3,400	300	---	300	[illegible]
Grand River, Grand Haven	---	9,300	---	9,300	9,300	240,000	---	7,500	---	9,300	2,300	9,300	300	4,300	43,000	43,000	4,300	9,300	4,000	6,000	11,000	---	[illegible]	[illegible]
Black River, Holland	91	9,300	---	9,[illegible]	430	24,000	---	2,400	---	2,300	<30	230	91	91	930	91	91	230	1,600	<200	100	---	---	[illegible]
Kalamazoo River, Saugatuck	230	430	---	930	930	>140,000	---	4,300	---	930	150	91	210	2[illegible]0	[illegible]30	91	2,300	430	---	200	300	---	---	[illegible]
Black River, South Haven	4,300	9,300	---	4,300	2,300	43,000	---	4,300	---	43,000	93,000	9,300	43,000	43,000	4,[illegible]	43,[illegible]	9,300	2,300	---	1,200	1[illegible]	---	---	[illegible]
St. Joseph River, St. Joseph	2,300	15,000	---	4,[illegible]	930	>140,000	---	23,000	---	>140,000	15,000	2,300	15,000	4,300	9,300	430	9,300	15,000	---	2,400	[illegible],850	---	---	14,[illegible]

Note: Results for 1965 and the first 5 months in 1966 are reported as MPN/100 ml.
Results for the remainder of 1966 are expressed as org./100 ml.

MAP 2

STATE OF MICHIGAN
MICHIGAN PORTION
LAKE MICHIGAN DRAINAGE BASIN

SAMPLING LOCATIONS — RAW WATER INTAKES


LAKE SUPERIOR
LAKE HURON
LAKE MICHIGAN
LAKE ERIE
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BASIN NUMBER	BASIN NAME	DRAINAGE AREA (SQ MILES)
1	MENOMINEE	2,087
2	CEDAR	387
3	FORD	477
4	ESCANBA	941
5	DAYS	73
6	RAPID	137
7	WHITEFISH	322
8	STURGEON	212
9	MANISTIQUE	1,450
10	PINE (BOYNE JORDAN)	370
11	ELK	452
12	BOARDMAN	295
13	BETSIE	252
14	MANISTEE	2,120
15	BIG SABLE	206
16	LINCOLN	99
17	PERE MARQUETTE	740
18	PENTWATER	172
19	WHITE	490
20	MUSKEGON	2,660
21	GRAND	5,530
22	BLACK (HOLLAND)	176
23	KALAMAZOO	2,060
24	BLACK (SOUTH HAVEN)	287
25	PAW PAW	444
26	ST JOSEPH	3,033
	MISCELLANEOUS	3,528
TOTAL		29,000

TABLE 4

SAMPLE RESULTS

DOMESTIC WATER INTAKES

LAKE MICHIGAN

1967

Intake Sampled	Total Coliform org/100 ml	Fecal Coliform org/100 ml	DO	BOD	S.S.	T.D.S.	pH	NO_3-N	Cl	NH_3-N	SO PO_4	Total PO_4	Fe	Ca	Mg	Na	K	SO_4	Alkal	Hard-ness	Phenol	CN	Cr^{+6}	As	Mn	Cu	F	Zn
1. St. Joseph, Michigan	700	180	10.4	-	13	170	8.2	0.30	6	0.0	0.00	0.25	0.8	40	12	5.1	0.8	30	125	150	0.000	0.00	0.00	0.00	0.0	0.0	0.20	0.0
2. Benton Harbor, Michigan	100	<10	11.2	-	12	155	8.2	0.25	6	0.0	0.00	0.20	1.2	36	11	4.8	0.7	24	115	135	0.000	0.00	0.00	0.00	0.0	0.0	0.10	0.0
3. South Haven, Michigan	300	30	9.6	-	12	165	8.2	0.35	8	0.0	0.00	0.25	1.0	40	12	5.5	0.8	29	120	150	0.000	0.00	0.00	0.00	0.0	0.0	0.10	0.0
4. Grand Haven, Michigan	<100	<10	--	-	6	170	8.1	0.30	10	0.0	0.00	0.20	0.1	40	12	6.9	0.9	29	125	150	0.000	0.00	0.00	0.00	0.0	0.0	0.20	0.0
5. Muskegon, Michigan	<100	10	--	-	8	135	8.2	0.20	4	0.0	0.00	0.20	0.1	36	10	4.4	0.7	19	110	130	0.000	0.00	0.00	0.00	0.0	0.0	0.15	0.0
6. Ludington, Michigan	600	20	--	-	9	185	8.2	0.20	24	0.0	0.00	0.25	0.3	44	11	6.0	0.9	23	115	155	0.000	0.00	0.00	0.00	0.0	0.0	0.10	0.0
7. Northport, Michigan	<100	<10	9.3	2.6	0	165	8.4	0.20	5	0.0	0.00	0.00	0.0	34	11	4.2	0.7	22	110	130	0.000	0.00	0.00	0.00	0.0	0.0	0.15	0.0
8. Traverse City, Michigan	<100	<10	9.3	1.9	0	175	8.4	0.20	5	0.0	0.00	0.00	0.0	36	9	4.2	0.7	20	110	130	0.000	0.00	0.00	0.00	0.0	0.0	0.10	0.0
9. Gladstone, Michigan	---	---	--	-	6	195	7.9	0.00	4	0.0	0.00	--	0.0	34	11	3.7	0.7	23	110	130	---	0.00	0.00	0.00	0.0	0.0	0.10	0.0
10. Escanaba, Michigan	---	---	--	-	4	150	8.0	0.10	4	0.0	0.00	--	0.0	36	11	4.1	0.7	23	110	135	---	0.00	0.00	0.00	0.0	0.0	0.15	0.0
Arithmetic Average ⟶					7	166	8.2	0.21	7.6	0.0	0.00	0.169	0.35	37	11	4.9	0.76	24	115	139	0.000	0.00	0.00	0.00	0.0	0.0	0.13	0.0

Note: All results are mg/l except pH and as otherwise noted.
Sample results were obtained from grab samples taken during summer and fall of 1967.

TABLE 5

LAKE MICHIGAN

SUMMARY OF WATER QUALITY

MUNICIPAL PLANT INTAKES

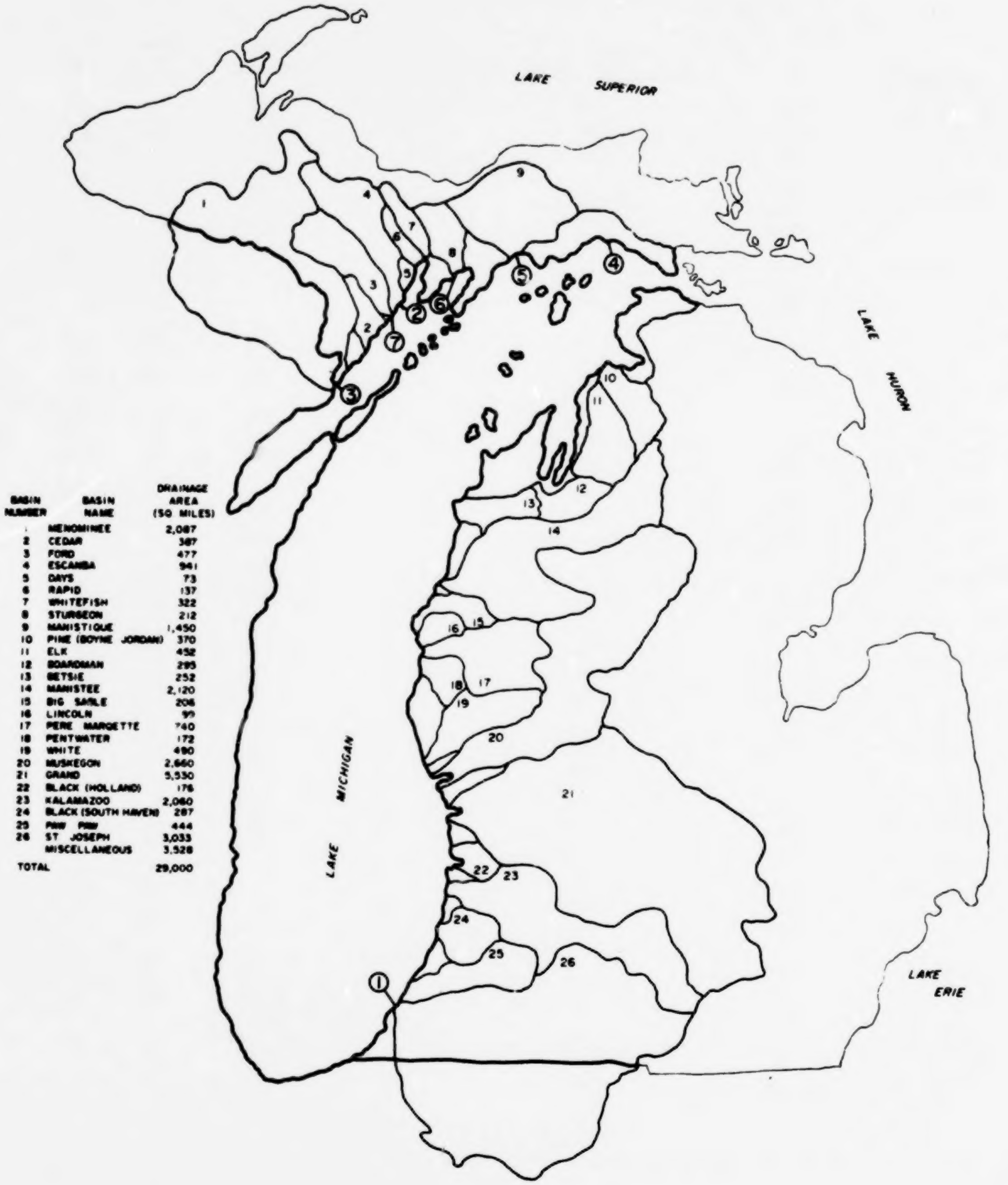
1966

Municipality	*	Coliform Tot. org./ 100 ml	Chlorides mg/l	Hardness mg/l	Temp °F	pH
St. Joseph	Min.	0	5	112	32	7.5
	Max.	11,000	13	232	76	8.8
	Avg.	1,325	7	145	50	8.1
Benton Harbor	Min.	0	4	120	33	7.7
	Max.	110,000	13	196	77	8.7
	Avg.	2,375	8	144	49	8.1
South Haven	Min.	4	7		33	7.8
	Max.	1,100	13		72	8.5
	Avg.	210	10		49	8.2
Holland	Min.	3	5	114	33	7.6
	Max.	46,000	12	151	73	8.8
	Avg.	512	8	119	48	8.3
Wyoming	Min.	0	7	125	31	7.6
	Max.	2,400	14	165	71	8.8
	Avg.	135	9	134	51	8.2
Grand Rapids	Min.	0	1	126	33	7.8
	Max.	2,400	15	166	73	8.7
	Avg.	Not determined	9	138	47	8.2
Muskegon Heights	Min.	0	1	124	33	8.0
	Max.	11,000	10	160	72	8.4
	Avg.	340	6	135	48	8.2
Muskegon	Min.	4		118	33	7.2
	Max.	11		154	73	8.5
	Avg.	155		133	46	8.0
Ludington	Min.	3	DATA	NOT	AVAILABLE	
	Max.	1,100				
	Avg.	60				
Traverse City	Min.	0		124	34	7.9
	Max.	30		140	80	8.6
	Avg.	5		129	48	8.3
Gladstone	Min.	3			33	7.0
	Max.	1,100			68	8.2
	Avg.	45			45	7.5
Escanaba	Min.	3		110	34	7.7
	Max.	430		136	70	8.5
	Avg.	35		125	42	8.1
Menominee	Min.	3		136	34	7.4
	Max.	24,000		112	70	8.5
	Avg.	300		129	47	8.1

* Data shown represent a yearly average, a yearly minimum and a yearly maximum.

MAP 3

STATE OF MICHIGAN
MICHIGAN PORTION
LAKE MICHIGAN DRAINAGE BASIN
SPECIAL SURVEYS


LAKE SUPERIOR
LAKE HURON
LAKE MICHIGAN
LAKE ERIE
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BASIN NUMBER	BASIN NAME	DRAINAGE AREA (SQ MILES)
1	MENOMINEE	2,087
2	CEDAR	387
3	FORD	477
4	ESCANBA	941
5	DAYS	73
6	RAPID	137
7	WHITEFISH	322
8	STURGEON	212
9	MANISTIQUE	1,450
10	PINE (BOYNE JORDAN)	370
11	ELK	452
12	BOARDMAN	295
13	BETSIE	252
14	MANISTEE	2,120
15	BIG SABLE	206
16	LINCOLN	99
17	PERE MARQETTE	740
18	PENTWATER	172
19	WHITE	490
20	MUSKEGON	2,660
21	GRAND	5,530
22	BLACK (HOLLAND)	176
23	KALAMAZOO	2,060
24	BLACK (SOUTH HAVEN)	287
25	PAW PAW	444
26	ST JOSEPH	3,033
	MISCELLANEOUS	3,528
TOTAL		29,000

TABLE 6

DATA FROM SPECIAL SURVEYS MICHIGAN'S PORTION OF THE LAKE MICHIGAN DRAINAGE BASIN

Station Number		Date 1967	Temp. °C	Total Coliform org/100 ml	Fecal Coliform org/100 ml	DO	BOD	pH	S.S.	T.D.S.	NO_3-N	NH_3-N	Total PO_4	Sol PO_4	Ca	Mg	Na	K	Cl	Hardness	Alkalinity	Phenol	Cn	Cr^{+6}	Fe
1	St. Joseph River at C & O Railroad Bridge in St. Joseph	7-19 7-20	22.7	44,000	2,600	13.9	9.8	[illegible]	51	320	0.00	0.0	0.80	0.05	58	23	8.5	0.9	10	246	175	0.00	0.00	0.30	--
2	Escanaba River at River Mouth	8-23 8-24	18.6	5,000	100	6.4	4.0	[illegible]	11	145	0.10	0.0	0.15	0.00	25	10	3.2	0.7	0	100	85	0.00	--	--	0.4
3	Menominee River, 1st Street Bridge in Menominee	7-24 7-25	24.1	[illegible]	--	8.2	3.2	[illegible]	[illegible]	160	0.00	0.0	0.15	0.05	26	7	2.1	0.5	0	95	80	0.00	0.00	0.00	0.25
4	Black River (U.P.) U.S.-2 Bridge, Naubinway	10-13	--	--	--	--	--	[illegible]	[illegible]	155	0.10	0.0	0.15	0.05	46	11	1.1	0.4	0	130	120	--	--	--	0.1
5	Manistique River (U.P.) M-219	11-14	--	--	--	--	--	[illegible]	25	175	0.10	0.0	--	0.00	27	6	1.6	0.5	0	92	70	--	0.00	0.00	0.5
6	Sturgeon River (U.P.) U.S.-2 Bridge	11-14	--	--	--	--	--	7.7	[illegible]	130	0.14	0.0	--	0.00	26	9	2.5	0.6	0	98	85	--	0.00	0.00	0.4
7	Ford River, U.S.-2 Bridge west of Escanaba	10-10	[illegible]	2,000	--	11.6	1.6	[illegible]	[illegible]	190	0.10	0.0	0.10	0.00	[illegible]	19	1.6	0.5	0	180	165	--	--	--	0.1

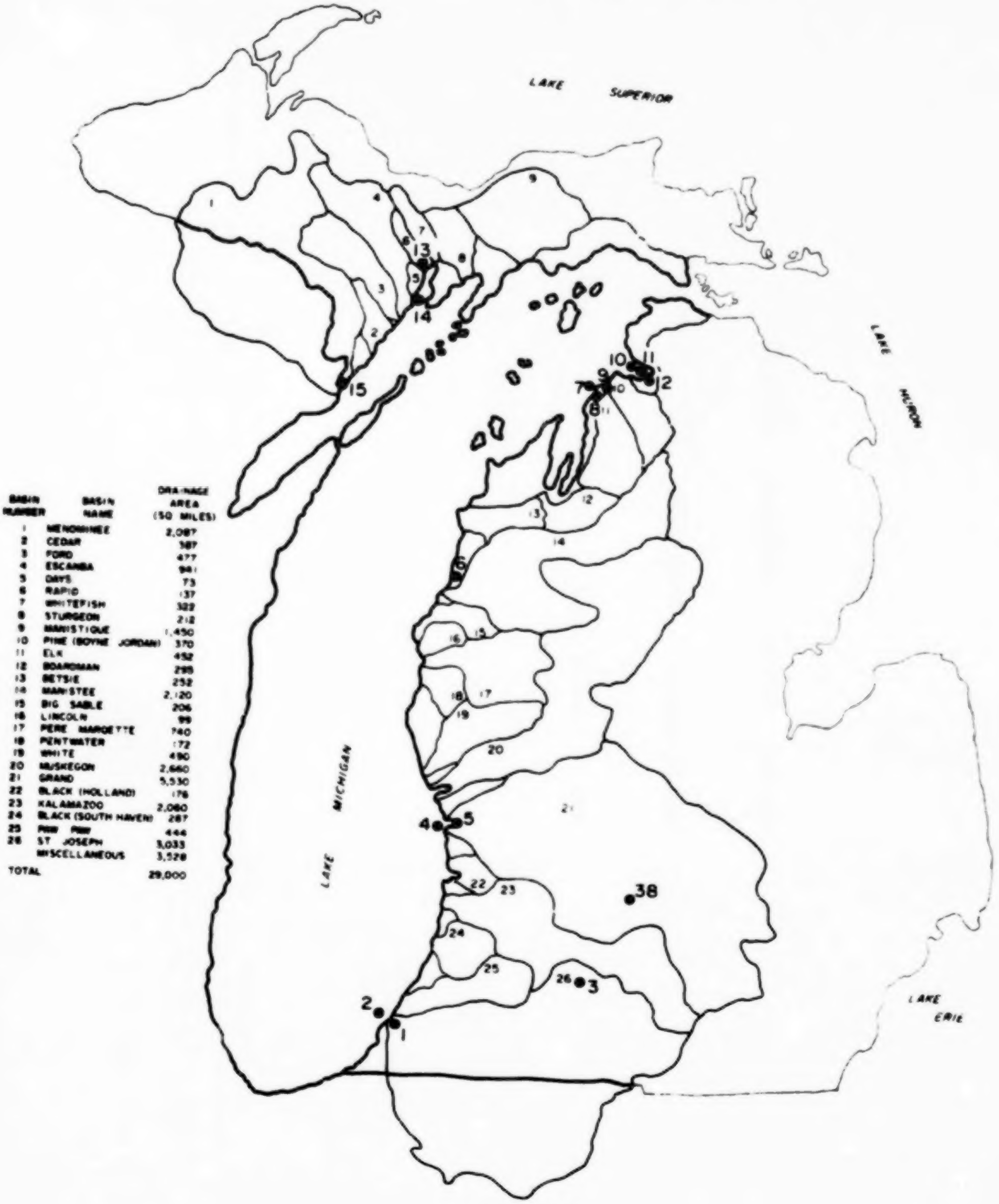
Note: Station numbers 1, 2 and 3 were 24-hour comprehensive surveys conducted during the summer of 1967. Station numbers 4, 5 and 6 were grab sampled once during 1967 as part of the interstate water quality monitoring program and station number 7 was grab sampled once during 1967 as part of a background water quality monitoring program.

All results are mg/l except pH and as otherwise noted.

MAP 4

STATE OF MICHIGAN
MICHIGAN PORTION
LAKE MICHIGAN DRAINAGE BASIN

RADIOACTIVITY SAMPLING LOCATIONS


LAKE SUPERIOR
LAKE HURON
LAKE MICHIGAN
LAKE ERIE
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BASIN NUMBER	BASIN NAME	DRAINAGE AREA (SQ MILES)
1	MENOMINEE	2,087
2	CEDAR	387
3	FORD	477
4	ESCANBA	941
5	DAYS	73
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11	ELK	452
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15	BIG SABLE	206
16	LINCOLN	99
17	PERE MARQUETTE	740
18	PENTWATER	172
19	WHITE	490
20	MUSKEGON	2,660
21	GRAND	5,530
22	BLACK (HOLLAND)	176
23	KALAMAZOO	2,060
24	BLACK (SOUTH HAVEN)	287
25	PAW PAW	444
26	ST JOSEPH	3,033
	MISCELLANEOUS	3,528
TOTAL		29,000

APPENDIX R

PHOSPHORUS INPUT
TO
LAKE MICHIGAN

Michigan Portion of Lake Michigan

Watershed Calculated P Inputs
By Sources Based on
Tributary Monitoring Data

To find the total amount of phosphorus (P) being contributed to Lake Michigan from Michigan lands and waters, drainage area and flow data were used from USGS records and PO_4 data from the Water Quality Monitoring Program. Calculations were made on a basin and/or region basis. Certain river basins have no flow data available since USGS does not have gaging stations on all Michigan streams. Flows for these streams were calculated by finding the ratio of flow (cfs) to area (sq. mi.) for an adjacent or similar basin and multiplying this by the area (sq. mi.) of the unknown basin.

The amount of phosphorus (P) contributed by each basin to Lake Michigan per year was calculated by use of the following formula:

Pounds P per year = MGY x 8.34 lbs/gal x Avg. mg/l P

Basins which have neither flow data nor PO_4 data available were calculated by using the average lbs. P/sq. mi. figure of an adjacent or similar basin.

The "miscellaneous basins" are drainage areas along the lakeshore which are not drained by a major stream. These areas were totaled and multiplied by the average lbs. P/sq. mi. figure for all basins.

The Menominee and St. Joseph rivers are interstate waters which drain lands other than Michigan lands. The Menominee Basin is equally proportioned, half in Michigan and half in Wisconsin. It was assumed that since the 2 halves of the basin are similar in population and types of land use that Michigan would be responsible for 50% of the phosphorus (P) present at the mouth of the river.

The St. Joseph River Basin was treated differently. PO_4 data from a river survey conducted July 17-20, 1967, was used to determine the proportion of the load from Michigan lands. There are gaging stations present at Mottville and Niles and samples were taken at these locations during the survey. Mottville is located near the Indiana-Michigan border just before the St. Joseph enters Indiana. Niles is located near the same border where the river enters Michigan again. The Michigan load should be equal to the load at the mouth, minus the load at Niles, plus the load at Mottville. Using this formula, it was determined that Michigan contributed 51% of the total phosphorus (P) load of the St. Joseph River.

The total calculated amount of phosphorus (P) contributed to Lake Michigan from Michigan lands and waters based on 1964 data was 1,728,806 pounds. The amount calculated from 1965 data was 2,721,838 pounds. This 54% increase can be attributed to the higher flows and more land runoff in 1965 than in 1964.

The following is a comparison of average river flows over the period of gage record to the average flows for 1964 and 1965. A check of the stations with the longest periods of record reveals that 1964 was a relatively dry year with flows averaging 30% below the long-term average, while 1965 was a slightly "wet" year with flows approximately 7% above the long-term average. This would indicate that 1965 better represents the "average" flow of Michigan tributaries to Lake Michigan.

Basin No.	Surface Waters	USGS Period of Record (years)	Average Flow For Period of Record (cfs)	Average Flow For 1964 (cfs)	% of Average Flow	Average Flow For 1965 (cfs)	% of Average Flow
1	Menominee	53	3,098	2,123		N.A.	
3	Ford	11	324	300		N.A.	
4	Escanaba	24	895	673		N.A.	
9	Manistique	27	1,330	1,179		N.A.	
12	Boardman	13	186	163	87	190	102
14	Manistee	14	1,933	1,697	88	2,059	106
15	Big Sable	23	137	129		N.A.	
17	Pere Marquette	26	608	513	84	739	121
19	White	8	367	301		458	
20	Muskegon	43	1,889	1,334	71	2,191	115
21	Grand	39	3,362	1,631	48	3,416	101
22	Black (Holland)	5	45.2	42.5		77.7	
23	Kalamazoo	35	1,296	770	59	1,188	92
25	Paw Paw	14	373	284	76.1	438	117
26	St. Joseph	35	3,025	1,464	48	3,043	100.6

Conclusions:

The estimated total phosphorus (P) contributed by Michigan to Lake Michigan in 1965 was 2,700,000 lbs. or about 7,400 lbs/day. This figure was obtained by multiplying average PO_4 concentrations obtained from a year-round monitoring program times average yearly flows of surface waters tributary to the lake. It should be recognized that some of the basins (40%) are not monitored for water quality or for flow and assumptions and extrapolation of data had to be made to allow calculation of the total phosphorus load. Thus the 2,700,000 lbs. is at best a rough estimate. The 1965 figures were used because they most nearly represent an average year for flow discharge to Lake Michigan.

If the 2,700,000 lbs. of phosphorus were spread evenly throughout Michigan's Lake Michigan basins it would equal about 90 lbs. of phosphorus per square mile per year, or if spread equally among the Michigan population it would equal about 1.2 lbs. of phosphorus per person per year. It is obvious that the phosphorus load is not spread evenly throughout the basins or equally among the population. Some of the phosphorus discharged in the upstream portions of the basin is utilized in the stream and may never reach the lake. Thus the 2,700,000 lbs. per year is the amount actually discharged to the lake and not the amount discharged throughout the basin.

TABLE 2

PHOSPHORUS CONTRIBUTED TO LAKE MICHIGAN BY MICHIGAN'S TRIBUTARY BASINS

Basin Number	River Basin Name	Drainage Area (Sq. Miles)	Flow at Mouth		Average PO_4 Content		Phosphorous Contributed by Basin		Pounds Phosphorous (PO_4-P) per Sq. Mi. Contributed by Basin		Population by Basin 1960	Population per Sq. Mi.	Pounds Phosphorous (PO_4-P) per Person per Year	
			1964 Calendar Year Average CFS	1965 Calendar Year Average CFS	1964 Average Soluble PO_4 mg/1	1965 Average Soluble PO_4 mg/1	lbs. Phosphorous (PO_4-P) per Calendar Year 1964	lbs. Phosphorous (PO_4-P) per Calendar Year 1965	1964	1965			1964	1965
1	Menominee (Mich.)	2,087	1,170	1,010	.15	.15	113,946	98,360	54.6	47.1	64,000	30.7	1.78	1.54
2	Cedar	387					4,404	2,581	11.4	6.7	2,000	5.2	2.20	1.29
3	Ford	477	320	490	.02	.01	4,157	3,181	8.7	6.7	1,500	3.1	2.77	2.12
4	Escanaba	941	730	920	.15	.15	71,095	89,596	75.6	95.2	13,600	14.5	5.23	6.59
5	Days	73					1,016	604	13.9	8.3	6,500	89.0	0.16	0.09
6	Rapid	137					1,907	1,134	13.9	8.3	2,000	14.6	0.95	0.57
7	Whitefish	322					4,482	2,666	13.9	8.3	2,500	7.8	1.79	1.07
8	Sturgeon	212					2,951	1,755	13.9	8.3	1,000	4.7	2.95	1.76
9	Manistique	1,452	1,550	1,850	.02	.01	20,182	12,011	13.9	8.3	9,000	6.2	2.24	1.33
10	Pine (Boyne - Jordan)	370	278	322	.01	.03	1,804	6,272	4.9	17.0	12,400	33.5	0.15	0.51
11	Elk	452					2,879	7,661	6.4	17.0	12,500	27.7	0.23	0.61
12	Boardman	295	220	250	.28	.13	40,037	21,100	140.5	74.0	29,400	99.7	1.36	0.72
13	Betsie	252					3,049	1,688	12.1	6.7	4,000	15.9	0.76	0.42
14	Manistee	2,120	1,980	2,200	.02	.01	25,710	14,283	12.1	6.7	31,100	14.7	0.83	0.46
15	Big Sable	206	210	250	.04	.10	5,454	16,231	26.5	78.8	3,100	15.1	1.76	5.24
16	Lincoln	99					2,622	7,800	26.5	78.8	3,100	31.3		2.52
17	Pere Marquette	740	530	770	.04	.10	13,764	49,992	18.6	67.6	23,800	32.2	0.58	2.10
18	Pentwater	172	124	179	.01	.01	805	1,162	4.7	6.8	7,400	43.0	0.11	0.16
19	White	490	390	590	.08	.09	15,192	34,475	31.0	70.4	20,100	41.0	0.76	1.72
20	Muskegon	2,660	1,510	2,480	.13	.12	127,444	193,215	47.9	72.6	192,000	72.2	0.66	1.01
21	Grand	5,530	1,840	3,860	.56	.46	669,006	1,152,795	121.0	208.5	949,000	171.6	0.71	1.21
22	Black (Holland)	176	113	210	.09	.24	6,603	32,722	37.5	185.9	51,000	289.8	0.13	0.64
23	Kalamazoo	2,060	990	1,530	.12	.07	77,341	69,534	37.5	33.8	417,000	202.4	0.19	0.17
24	Black (South Haven)	287	184	342	.29	.49	34,645	108,800	120.7	379.1	29,000	101.1	1.19	3.75
25	Paw Paw	444	320	500	.29	.49	60,415	159,064	136.1	358.3	50,500	113.7	1.20	3.15
26	St. Joseph (Mich.)	3,033	1,250	2,201	.30	.25	243,475	357,266	80.3	117.8	211,300	69.7	1.15	1.69
	Miscellaneous Basins	3,528					168,991	275,890	47.9	78.2	133,100	37.7	1.27	2.07
	TOTAL	29,000					1,728,806	2,721,838			2,281,900	78.69	0.76	1.19

Note:
1) Flow for basins 2, 5, 6, 7, 8, 10, 11, 13, 16, 18, and 24 were obtained from yield ratios of similar basins.
2) PO_4 values for basins 2, 3, 5, 6, 7, 8, 9, 10, 11, 13, 15, 16, and 25 were obtained from yield ratios of similar basins.
3) PO_4 values for basins 1 and 4 were obtained from comprehensive surveys.
4) The values used for the "miscellaneous basins" were averages of all basins.

MR. STEIN: We will recess now. Our present plans call for a reconvening at 9:30 at the same place tomorrow at which time we will hear from Wisconsin. The Wisconsin presentation, including its participants, is estimated to take about two hours.

After that we will have questioning of Mr. Schneider on the Federal Recommendations and conclusions. If anyone has anything he wants to contribute, he should get in touch with his State representative or the Chairman, because this phase of the Conference may be coming to a close.

We stand recessed until 9:30 tomorrow morning.

(Whereupon, at 6:00 p.m., an adjournment was taken.)